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ARBORETUM BULLETIN

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Borderline Plants – A Follow-up

The article on gardening with borderline plants in the last issue by Dr. Arthur Kruckeberg has elicited considerable interest among our readers. The Arboretum staff and the editorial board of the *Bulletin* would be grateful for any information about tender plants being grown in the Pacific Northwest. We are interested, for example, in species of *Acacia,* large-leaved rhododendrons or those of the Maddenii series, Asiatic species of *Gaultheria,* the loquat *(Eriobotrya japonica),* those plants marked + in the Arboretum catalogue or any others considered to be tender.

Desirable information might include: source of material, location of garden, type of soil, exposure, the kind of protection if any, its age, present size, and flowering and fruiting performance.

We have already had the offer of a "Vignette" about *Punica granatum.* This is only one way the information can be used. If there is sufficient response, the *Bulletin* can follow up with an analysis of the data received.

But most important, such reports will add to the body of horticultural knowledge about the kinds of plants that are successful in this area and under what conditions they grow. Perhaps some unexpected information will emerge.

It is obvious from articles such as Dr. Kruckeberg's, from the *Nothofagus* series in this issue, from the report of the Arboretum's frost hardiness study and Brian Mulligan's not infrequent allusions to desirable plants that barely survive here — if at all — that hardier seed sources from higher latitudes and elevations are a necessity if we are to augment the selection of plant material that can succeed in our climate.

Think about it! What information can you supply? And what steps can we take to enrich our gardens?

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COVER
London Plane trees *(Platanus acerifolia)*
flanking the monorail on 5th Avenue
See article on p. 26
Photo: Nancy Walz

The Genus *Nothofagus*

The following articles have been planned as a unit to create a sustained interest in a group of trees that is little known in the Pacific Northwest. Aside from its evolutionary significance, the genus Nothofagus *presents an exciting potential here for gardens and for public plantings. The Arboretum has been growing and testing a number of the hardier species. We shall let these articles tell their own story.*

Biogeographic Patterns In the Southern Beeches *(Nothofagus)*

*ROGER DEL MORAL**

Introduction

The genus *Nothofagus,* the southern or false beeches, consists of about 39 extant species distributed exclusively in the Southern Hemisphere. The genus has a central role in understanding the historical biogeography of the Southern Hemisphere because it is abundantly represented in the fossil record and it displays an enigmatic contemporary distribution. The pollen record of the cooler portions of the Southern Hemisphere is saturated with the unmistakable pollen of *Nothofagus*. Interpretation of this record provides some of the major pieces of evidence for previous land connections among the major land masses and for substantial climatic changes.

Many of these species have horticultural value in the Pacific Northwest. This paper has been prepared in order to help foster a greater appreciation of the diversity and importance of this genus.

Biogeography and Taxonomy

In South America, the southern beeches range from about 33°S. to 55°S. They occur primarily along the Andean axis and, particularly in Tierra del Fuego, they form impressive, dense forests. In New Zealand, the cool, temperate forests that dominate the mountainous regions of South Island are covered by *Nothofagus*. While portions of the North Island also contain *Nothofagus* forests, many of these have been replaced by commercial softwood plantations. The wetter portions of Tasmania are dominated by a single species and there are small, scattered relict stands on the Australian mainland. Many species of beech are also found in the cool highlands of New Guinea and New Caledonia.

Both the current geographic pattern and the fossil record suggest a group adapted to cool, temperate regions, with a Southern Hemisphere origin. Ecologically, the southern beeches resemble both true beeches *(Fagus)* and some oaks *(Quercus)*. The New Guinean and New Caledonian populations, though they occur in tropical latitudes, are distributed almost exclusively in the cool, wet highlands.

There are two taxonomic sections of *Nothofagus*. With the exception of the Tasmanian subalpine endemic, *N. gunnii,* the deciduous species (section *Nothofagus*) occur only in South America. Section *Calusparassus* consists of 31 evergreen species, of which only three are found in Chile. Within this section there are two subsections, based on capsule characteristics.

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*Roger del Moral will be remembered for his recent article on the botanical gardens at Canberra (40:2, 1977) and for a discussion of allelopathy in the summer issue of 1973 (36:2). Photos appearing in this article are by the author.

Subsection Bipartitae, which is characterized by the two-valved cupule, includes 21 of the tropical species, divided into two series, depending upon the number of nuts per cupule. The remaining species are placed in subsection Tripartitae, which is characterized by three-valved cupules, and which consists of nine temperate zone species.

The floristic distribution and tertiary distributions of *Nothofagus* are summarized in Table 1. A more complete treatment of this information may be found in van Steenis (1971). Note that only in New Guinea are there as many extant species as there are known from fossils.

Since *Nothofagus* is a temperate group, it is scarcely surprising that it is confined in New Guinea to cool-to-cold upland rainforests. Only two species are found below 1000 m into warmer forests, while 16 species extend well beyond 2000 m. In contrast, *Nothofagus* forests in New Caledonia nearly reach sea level. Apparently, this is a response to the moderating effect of the sea and the higher latitude of this small island. The New Caledonian species seem to have been derived from the New Guinean species in the distant past. The evidence for this is that the two groups of species have distinctive phyllotaxi*, suggesting ancient separation, but two of the New Caledonian species are closely related to two New Guinean species.

There are but three species in Australia. *N. moorei* occurs in scattered subtropical locations and is clearly a relict of wetter times. *N. gunnii,* a shrubby, deciduous form, is confined to the subalpine slopes of southwestern Tasmania. The most common Australian species is *N. cunninghamii,* which dominates wet forests in south and west Tasmania and which occurs sporadically in gullies and wet forests in eastern Victoria. The latter species have distinct temperate affinities.

There are five evergreen taxa in New Zealand. *N. solandri* var. *solandri* is a montane forest tree reaching 24 m in height, while *N. solandri* var. *cliffortioides* is common in higher, drier subalpine forests. *N. menziesii* is the most common beech in New Zealand. On South Island, it forms dense, impressive and often impenetrable forests. *N. fusca* is a common forest tree found on the lower slopes of both islands. The fourth species, *N. truncata,* is relatively rare and has a scattered distribution.

The South American species form dense forests on the Andean slopes from montane to subalpine habitats. Because of the substantially earlier colonization by Europeans, these forests have suffered from logging far more than their counterparts in Australia and New Zealand. The eight deciduous species include *N. betuloides* and *N. obliqua*. There are also three evergreen species.

Historical Distributional Pattern

The biogeographic interest of *Nothofagus* resides in its past distribution. What these patterns tell us of past geography and climatic patterns is important to general biological theory. We have seen that *Nothofagus* is currently distributed in several places widely separated by

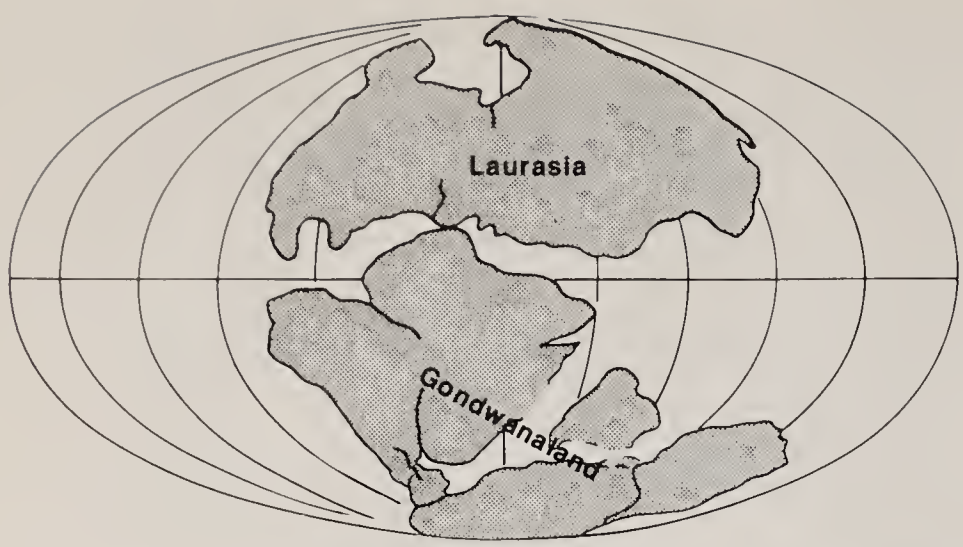
*the arrangement of leaves on a stem and in relation to one another.

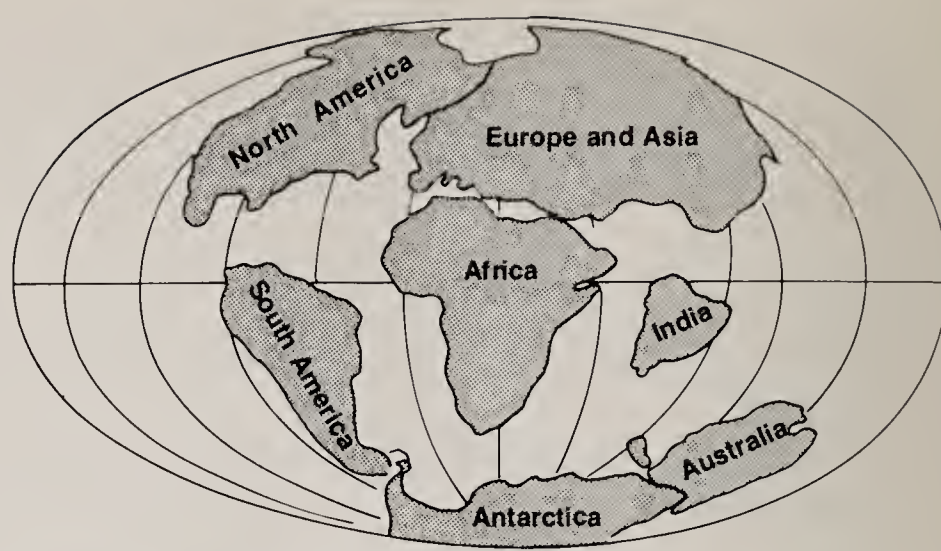
Table 1. Past and Present Distribution of *Nothofagus*

REGION	NUMBER OF SPECIES		
	Past	Present	
		Deciduous	Evergreen
New Caledonia	No fossil Record	0	5
New Guinea	±15 during the Miocene	0	16
Australia	10-20, since the Cretaceous	1	2
New Zealand	20-30, since the Cretaceous	0	4
Antarctica	±20, during the Paleocene	0	0
South America	±20, since the Eocene	8	3
	TOTALS	9	30

Table 2. Geologic Time Scale

ERA	PERIOD	EPOCH	Million Years Ago (mya)
CENOZOIC	Quaternary	Holocene	0.01
		Pleistocene	2.5-3
	Tertiary	Pliocene	7
		Miocene	26
		Oligocene	37
		Eocene	54
		Paleocene	65
MESOZOIC	Cretaceous (135-65 mya)		
	Jurassic (135-180 mya)		
	Triassic (180-225 mya)		





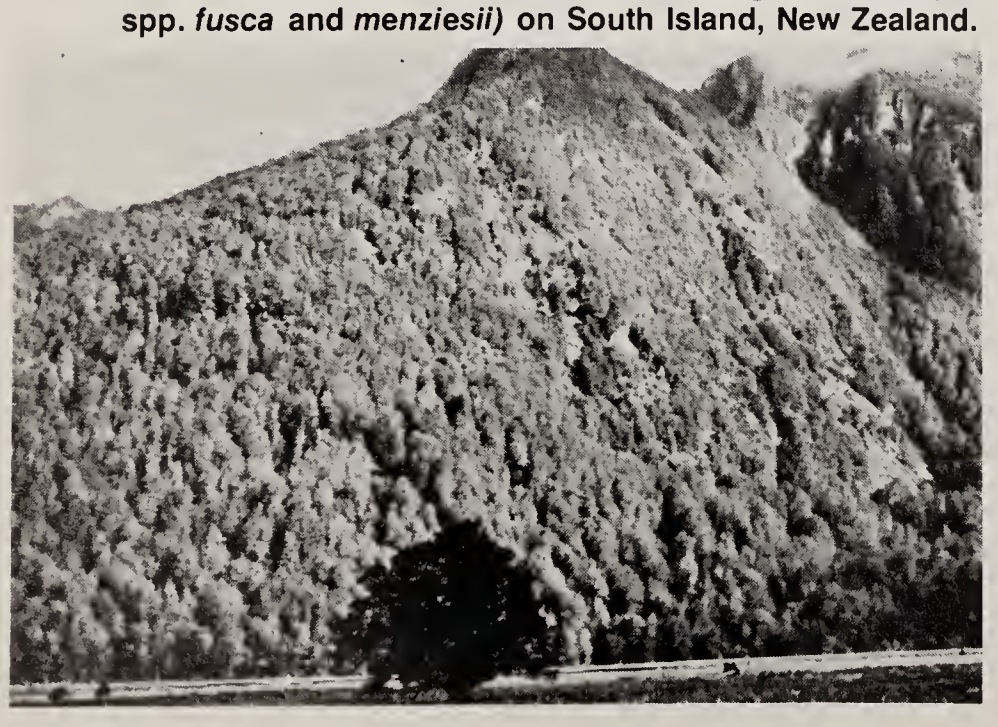
Former distributions of continents: left, about 180 mya; right, about 135 mya. Graphics: Floyd Bardsley

sea water, yet its seeds are quite large and dispersal is poor. In addition, fossil pollen has been found over a much broader area than the current distribution would suggest. Indeed, there are many records from Antarctica and its adjacent islands. These fossils date from the Upper Cretaceous (75 million years ago). This record of fossil finds indicates on the basis of morphological similarities that the Antarctic flora was more similar to that of New Zealand than it was to that of South America. How could this distributional pattern arise?

The *Nothofagus* fossil record is consistent with the presence of a megacontinent, called Gondwanaland, that existed prior to the time during which angiosperms achieved their current dominant status, sometime by the Middle Cretaceous. This continent consisted of Antarctica, Australia, New Zealand, South America, Africa and India. Gondwana was fragmented after the angiosperms began their rapid evolution but before many families had fully differentiated.

In the case of *Nothofagus,* the initial rafting of continents seems to have occurred while the beech was still relatively undifferentiated. Indeed, India and Africa appear to have departed prior to the development of any recognizable *Nothofagus* fossils. The disruption of the remaining fragments may have spurred speciation. The current distribution and diversity of *Nothofagus* is but a bare remnant of its former importance. While pollen types in the fossil record cannot be identified to the species level with any precision, both Crandell and van Steenis agree that over 100 species once existed and that many more can be inferred. The areal distribution was once far greater than it is today. Let us turn to the example of Australia.

Hillside covered with a dense *Nothofagus* forest *(N.* spp. *fusca* and *menziesii)* on South Island, New Zealand.



There exist three pollen types. *Brassii* pollen is the earliest found in the fossil record and is confined to the subsection Bipartitae. *Fusca* and *menziesii* pollen types occur in both sections; *fusca* appears earlier in the fossil record.

Brassii pollen appears in the earliest records (Upper Cretaceous) but becomes extinct in Australia by the Pliocene. In contrast, *fusca* and *menziesii* types do not occur until the Eocene and still occur. Once there were between 10 and 20 species of *Nothofagus* distributed throughout the west, south and east of Australia. *Brassii* pollen dominates the record during this period of maximum species richness and distribution. With the retreat of the epicontinental seas that once covered much of Australia and the development of cold, dry conditions during the Pliocene and Pleistocene, an arid continent was created and the extinction rate of *Nothofagus* accelerated. Today, only in the cool, temperate reaches of southwestern Tasmania can any *Nothofagus* species be said to be a forest dominant.

While *brassii* pollen represents an ancestral type, being the first to occur in all regions where it is found, today it is found only in the cool, temperate uplands of the tropics. This fact indicates to some that *Nothofagus* originated in the Guinean to Indonesian region. However, the

absence of an early fossil record in this region prior to the Miocene, coupled with the more northerly latitude of Antarctica during the Cretaceous, suggests to others that the origins are to be sought in the formerly cool, temperate lowlands of Gondwanaland remnants.

Given a large southern continent, now confirmed by geological evidence and predicted by the theory of continental drift, generally warmer climatic conditions, and the more northerly distribution of Antarctica, *brassii* type species of *Nothofagus* could have originated in regions where this type no longer occurs and that are now found far to the south. Following their origin, the evolution of the other types, better adapted to temperate latitudes, would occur, while the *brassii* type could migrate into the highlands of tropical latitude and subsequently become extinct in the land of its origin.

An Example of Current Distribution: Nothofagus cunninghamii

Nothofagus cunningharnii dominates the wet forests of southwestern Tasmania. The climate of this region is reminiscent of that of the Pacific Northwest because it receives over 100 inches of rain per year. Precipitation peaks in the winter months. Frosts are uncommon and the summer temperatures are mild. Despite the presence of several species of locally dominant conifers (e.g. *Phyllocladus asplenifolius, Dacrydium franklinii, Callitris oblonga, Athrotaxis cupressoides,* and *A. selaginoides*), it is the "myrtle" that dominates these forests. *N. cunninghamii* can grow to become a magnificent, epiphyte-bedecked plant which suggests that cultivation in Northwestern parks and arboreta would be a meritorious endeavor.

Fire is a major component of most Australian environments. Thus, in marginal *Nothofagus* forests, fire results in a canopy consisting of a mixture of *Eucalyptus* species (e.g. *E. globulus, E. delagatensis, E. regnans,* and *E. obliqua*) with an understory of mature myrtle. Low fire frequency permits species of *Acacia, Pomaderris* and other wet sclerophyll species to become prominent. Under a more frequent fire regime, the myrtle is entirely replaced by the *Eucalyptus* forest.

The mature *Nothofagus* forest is characterized by a high proportion of ferns and mosses. For example, Howard and Ashton (1974) found

A "young" tree of *N. cunninghamii* in Tasmania.

2 tree species, 8 shrubs, 3 lianas, 9 herbs, 19 ferns, 4 filmy ferns, 29 mosses, 22 liverworts and 1 lycopod. This list indicates cold, wet conditions with limited light at the forest floor and is similar to what would be expected in coniferous forests of the Pacific Northwest. Moderate summer rainfall and low fire frequency combine to account for the dominance by the broadleaf evergreen *Nothofagus* rather than by conifers. Whereas Tasmanian summers receive 21 percent of the annual rainfall, Northwest summers receive under 10 percent. This contrast may explain the failure of structural convergent evolution of the dominant canopy species in otherwise similar environments.

Conclusion

Temperate species of *Nothofagus* are strikingly beautiful trees when mature and the foliage of many species is handsome. Several species merit trials in the Arboretum. Indeed, *N. solanderi* var. *cliffortioides* and *N. dombeyi* have grown well in the Arboretum and appear to be sufficiently hardy to withstand local winter conditions (Hatheway *et al.,* 1977). *N. menziesii,*

N. solandri and *N. truncata* from New Zealand, and *N. cunninghamii* and *N. gunnii* are species that I would recommend for trial. *N. menziesii* has been tried, but died in 1955. For the New Zealand species a South Island seed source is advisable. Seed selected from frost free habitats should be avoided, a condition which should eliminate species such as *N. moorei*. Care in obtaining the appropriate seed source is indicated.

Acknowledgements

This study was prepared while I was on professional leave at the University of Melbourne, Parkville, Victoria. I am indebted to Dr. David H. Ashton for providing me with access to several dissertations and to Mr. A.D. Mount who introduced me to some magnificent *Nothofagus* forests in Tasmania.

REFERENCES

Hatheway, W.H., H. Kohn, and J.A. Witt. 1977. The frost hardiness research program. U.W. Arboretum Bull. 40:2-8.

Howard, T. and D.H. Ashton. 1974. The distribution of *Nothofagus cunninghamii* rainforest. Proc. Roy. Soc. Victoria 86:47-75.

van Steenis, C.G.G.J. 1971. *Nothofagus,* key genes of plant geography, in time, space, living and fossil, ecology and phylogeny. Blumea 19:65-98.

The *Nothofagus* Collection in the Arboretum

JOSEPH A. WITT

Members of the genus *Nothofagus,* the southern beech, were relatively late introductions to the Arboretum's collections. The first successful planting of these southern hemisphere trees was not until 1948, thirty years ago, when one plant of *Nothofagus obliqua* was imported from England. There may have been earlier, but unsuccessful attempts to establish them, but if so, our records do not show this nor when they were planted or why they were lost. However, once a successful introduction was achieved others followed with some regularity and continue up to the present.

The southern beech are members of the oak family, *Fagaceae*. Hence it was only natural that the first plantings should have been made in the oak section where their northern hemisphere relatives, the beech, *Fagus,* were already growing. The first species to be planted in this area was the South American roblé*, *N. obliqua* in 1949. In 1953, '54 and '55, a number of other species joined this pioneer. Unfortunately the devastating cold of November, 1955 killed or cut back many of the newly planted trees and while some made a good recovery, .others were eliminated. Later plantings were made in areas other than the oak section which were chosen for suitability of site rather than for familial grouping.

The Arboretum's collection of *Nothofagus* includes nine species and one variety, about one fourth of the total number of species now known. Of these ten taxa, only six are well-established; the others are newly received or of questionable hardiness and must be tested by a hard winter before they can be considered permanent.

The most successful members of the genus here are, perhaps not surprisingly, from temperate South America. The New Zealand species have been less satisfactory and with the exception of *N. solandri* var. *cliffortioides,* our specimens are still small. We have never tried those from New Guinea and New Caledonia although high-elevation species should be tested when possible.

The following species are now planted out on the Arboretum grounds:

*The common names given are those used in the trees' native lands. They are so rare in cultivation in this area that no common names have developed.

Nothofagus antarctica, ñirre, is from Chile and Argentina where it extends north from Cape Horn into the Andes, becoming a timberline species there. In the Arboretum, it has an erect habit with branching arranged in open layers. The branches are often irregular and sinuous giving the tree a striking winter outline. Its bark has strong vertical striations that ultimately become irregular chips or flakes. The deciduous leaves are from half to an inch long, ovate and with a crisped or wavy margin, borne alternately on short lateral twigs. These are medium green changing to orange-brown before falling. It has flowered, but to date no fruits have been found.

There are plants from three sources growing in the Arboretum: one lot from the Botanic Garden, Buenos Aires, Argentina, one from Hillier & Sons, England and one from the Hollandia Garden, Seattle. All plants are more or less similar except for one vigorous tree growing near the lagoons at the north end of the Arboretum which has developed a narrow upright habit. We are propagating this specimen vegetatively to see if it will continue its fastigiate habit since it might prove to be an interesting street tree if it does.

Our largest tree, the plant mentioned above, is 38 feet tall with a trunk diameter of 11.3 inches. The next largest, planted in the oak section, is 28 feet tall and has a diameter of 5.2 inches.

Nothofagus dombeyi, coigüe, is an evergreen southern beech from Chile and western Argentina where it has an extensive north-south range in the Andes. The Arboretum's plants were introduced first from the Arboretum des Barres, France as seed in 1949 and again in 1956 from a local nurseryman, Lester Brandt.

Winter silhouette of *N. antarctica* growing in the lagoon area of the Arboretum. Photo: Nancy Walz

The largest of the genus in the Arboretum, it is an upright tree varying from an open habit where it is growing in shade in the oak section, to a more compact form in an exposed site in Rhododendron Glen. Its bark is brown, checked and furrowed at the base, but becoming smooth and strongly marked with horizontal striations in the upper portions. The branches are somewhat tiered and sinuous in the shade, more densely arranged and ascending in the open. Its leaves are small, about three-fourths to an inch long, ovate, serrate and dark green. They remind one of the evergreen huckleberry, *Vaccinium ovatum.* It has not flowered or fruited so far.

As mentioned above, the coigüe is the largest of the Arboretum's *Nothofagus*. One tree planted in 1954 is now 60 feet tall with a diameter breast high (d.b.h.) of 9.6 inches. Another planted a year earlier is only 36 feet tall. The tree in Rhododendron Glen was set out in 1961 and is a

Branch of *N. antarctica*. Photo: Pat Harrigan

handsome plant with the habit of a dark green *Cedrus atlantica* and is 42 feet tall with a d.b.h. of 9.0 inches.

Nothofagus obliqua, roblé, also from Chile and western Argentina, is a major timber tree in those countries whose wood is similar in appearance and use to oak. It is deciduous with an erect open habit, reported to be over 100 feet tall in its native habitat. Specimens in the Arboretum are perhaps the most round-headed of any of our *Nothofagus,* although there is some tendency for the lower branches to weep down. The bark is gray and checked and sometimes flaking. The leaves are oblong to ovate, one to three inches long, dark green above, paler beneath and turning golden yellow before dropping. A large tree of roblé fruited in the nursery and seeded itself prolifically in the light sandy soil there. The fruits are inconspicuous as are the flowers.

As mentioned above, *N. obliqua* was the first of its genus to be planted in the Arboretum. One original tree imported from the Hillier Nursery, England is still extant, but is much surpassed in size by later additions to the collection. The largest tree, received as a plant from an English nursery in 1950, is now 46 feet tall and 8.5 inches d.b.h. after being planted in 1952. Another specimen planted in 1961 and only a foot less tall with a trunk diameter of 12.1 inches came from seed collected in Argentina in 1956. See page 10, Figs. 2 and 3, for the leaves and bark of *N. obliqua*.

Nothofagus procera, rauli, is the fourth Chilean species in the collection. A deciduous tree, it has not done well with us probably because of the heavy wet soils in which it is planted. The single specimen was planted in 1964 and is now 16 feet tall with a 2-inch calliper trunk. Its leaves are larger than the other nothofagi, up to 4 inches long, oval and obviously ribbed. They turn apricot-orange in the autumn. It was raised from seed received in 1960 from the National Pinetum, Bedgebury, England.

Nothofagus pumilio, lenga, is the latest of the South American species to be introduced to the collections. A plant ten inches tall was received from the Royal Botanic Gardens, Edinburgh, Scotland in 1970. It was planted in the lagoon area in 1976 and is now nine feet tall and thriving. This species should be perfectly hardy here, since it is found as far south as Tierra del Fuego and as high as 6000 feet in the Andes farther north. Its foliage resembles *N. antarctica* but is slightly larger. Time alone will tell how successful it will be, but so far the single tree looks promising.

Nothofagus solandri var. ***cliffortioides***, mountain beech, is the most successful New Zealand *Nothofagus* introduction to date. Originally raised in 1952 as *N. cliffortioides* from New Zealand seed, two plants were set out in 1954. One died in the 1955 freeze; the other was killed to the ground, but re-sprouted and is now 31 feet tall with a trunk diameter of only 4.6 inches.

A high elevation species, it is reported to be a small tree, not much taller than 50 feet in New Zealand. Our plant has an erect habit with gray-brown, smooth bark, sinuous branches decked with ovate leaves between one fourth and one half inches long, olive green in color and arranged in a tidy pattern along the upper side of the twigs. We have seen neither flowers nor fruits. Although this specimen still is growing at a rate of about a foot a year, it does not appear to be especially healthy, perhaps because it suffers from our colder winters. Bonsai enthusiasts have been taken by its interesting branching habit and small neat leaves, but so far we have been unsuccessful in propagating it vegetatively.

* * *

Four other taxa now are under trial in the Arboretum including two newly received: *Nothofagus solandri* var. *solandri* from New Zealand and *N. betuloides* from South America. The former has been tried before, but was lost to cold. The South American species has not been available before although it should prove to be as successful as *N. dombeyi.*

Nothofagus fusca and *N. menziesii* are species that have been tried and lost several times earlier. Evergreen and from New Zealand, there should be some hope for our growing them in a sheltered location since both are found with some regularity in British gardens. *Nothofagus fusca* was planted out in 1975 after growing in the

N. dombeyi. **Graceful habit of the tree, left; photo: Nancy Walz. Close-up of the trunk (diameter 3.75 inches), right; photo: Brian O. Mulligan**

lath house for five years and being severely damaged even in that protected site. If it will survive the next few winters, it may be that we can safely add it to our list of successes. *Nothofagus menziesii* is still in the nursery where it too has a history of being cut back by our colder winters. Tiny fan-shaped leaves on willowy slender branches indicate that it might be a real gem if we can find the right location for it. Both species were raised from seed collected in New Zealand.

The southern beech, aside from their tendency to be injured by hard frosts, seem to be quite easy to cultivate. We find they have grown much better in loose well-drained soils than in the heavy soil found in the oak section, and those taxa we are growing respond best to full sun or light shade rather than to full shade. With the exception of *N. solandri* var. *cliffortioides,* we have been able to propagate them from cuttings taken from soft wood in the summer or from hardwood cuttings later in the year. Seeds when available, however, seem to be the easiest way of increasing them.

Only *N. antarctica* and *N. solandri* var. *cliffortioides* are of a size that would fit into the smaller garden and even they may go over 50 feet in height. All the other species require a great deal more space and are best suited to parks or large estates. We have had few disease or insect problems with the *Nothofagus.* There is some leaf-margin burn on one roblé which may be due to drought, but aside from an occasional scale attack, they seem remarkably clean. ♠

Recommended Sources for *Nothofagus* Species

Gossler Farms Nursery — 1200 Weaver Rd., Springfield, Or. 97477 — (503) 746-3922
Hollandia Gardens — 10725-39th N.E., Seattle, Wa. 98125 — (206) 363-6080
MSK Nursery — 20066-15th N.W., Seattle 98177 — (206) 546-1281
Wells-Medina Nursery — 8300 N.E. 24th, Bellevue, Wa. 98004 — (206) 454-1853

AND
The Arboretum Foundation Plant Sale
May 5 and 6, in the parking lot of the Arboretum administration buildings

Leaves of *N. alpina* (Fig. 1, left) and *N. obliqua* (Fig. 2, right).

The Southern Beeches of Strybing Arboretum

KAREN BRILL PIHL
Strybing Arboretum Society

The beeches of the southern hemisphere, *Nothofagus,* are a diverse group with more species than their northern hemisphere counterparts, *Fagus,* and with a greater variety of habitats. The name *Nothofagus* means false beech. For the most part, they are evergreen trees, native to Chile, Argentina, Australia, New Zealand, New Caledonia and New Guinea. Strybing Arboretum in San Francisco's Golden Gate Park has both evergreen and deciduous representatives of the genus.

Of the deciduous species, *N. alpina* was received in October, 1962 from the University of Washington Arboretum. It is now (in June, 1977) approximately 11 feet high with a trunk circumference of 2¾ inches. The leaves of *N. alpina* are distinctive, with plicate (accordian-pleated) folding which is characteristic of certain members of the genus (Fig. 1). Our specimen is growing in a sunny area. The drought may partially explain its current less than noteworthy appearance. It is not a very dense tree; there are few leaves and the branches are not close together.

The Arboretum has two large specimens of *N. obliqua,* the roblé beech. One has a trunk circumference of 79 inches and the other, 73 inches; they are at least 50 feet tall. Since they were introduced before the current accession system was set up, no information is available about them other than that they were planted prior to 1957. They are well-established in one of the less-frequented areas of the Arboretum, which contains many old specimens, and form part of the canopy in this area. Both trees have arching branches crowded with large, triangularly-toothed leaves (Fig. 2). Only one of the plants has branches within reach, and no reproductive structures are visible from the ground, but twigs with fruit may be found under the tree. The involucre surrounding the fruit is square, and the winged nutlets are of

Fig. 3. Bark of *N. obliqua*.

two types, either flattened or triangular. The bark is rough and gnarled (Fig. 3). Older twigs are a shiny, reddish-brown with protruding leaf scars and prominent, lighter-colored lenticels.

In Chile and Argentina, the southern beeches were once the dominant trees. The roblé has the northernmost distribution; farther south, it is found with *N. dombeyi.* It grows below 5000 feet in the mountains, replaced at higher elevations by *N. pumilio* and *N. antarctica.* Its southern limit is about 41°S.

N. antarctica, Antarctic beech, was received bare root from the University of Washington Arboretum, in October, 1963 and by June, 1977 it is approximately 17 feet high with a trunk circumference of 15.5 inches. It now bears fruit similar in appearance to that of *N. obliqua;* the involucre is tinged with red. Strybing's Antarctic beech is planted next to the Zellerbach Garden in full sun and it is thriving in this location. The leaves are close together, less than an inch long, toothed and ovate to triangular. When young, they may have a pleasant honey fragrance (Bean, 1976). They are oriented on the branches almost in a single plane. The bark is smooth with long, straight lenticels.

In its native South America, the Antarctic beech has a subalpine distribution, growing above the evergreen beeches from latitude 38° south to Tierra del Fuego. It is a small tree and may be shrubby in exposed areas. On eastern slopes it is found at lower elevations.

Evergreen representatives at Strybing include *N. solandri,* black beech, which was received as an eight-foot specimen from Mrs. W.P. Roth of Filoli, San Mateo County, California in November, 1970. It is now approximately 17 feet high with a stem circumference of seven inches. *N. solandri* is native to lowland and mountain forests of New Zealand. Its leaves are small, oval and entire with an orderly arrangement in one plane on the branches (Fig. 4). Although the leaves are set close together, the branches are not, giving the tree an open appearance. The bark is smooth and gray.

Evergreen *N. moorei,* Australian beech, was until recently misidentified in our records; since the source of the error is not known, the accession information below may be incorrect. Two plants assigned the number now on *N. moorei* were received by Strybing from the University of Washington Arboretum in November, 1962 in four-inch

Fig. 4. *N. solandri.*

pots. The original source of these plants is recorded as the Botanical Garden, Buenos Aires, Argentina. One of the original two is now dead and the other has not been located. Strybing's current specimen was propagated by a cutting, presumably from one of the original plants, and was planted out in January, 1977. It is now 44.5 inches tall and is planted in full sun near *N. antarctica.*

N. moorei has striking, shiny, toothed leaves, dark green above, lighter green below and again disposed in one plane on the branch. The veins are prominent and nearly parallel. The buds are an attractive red.

This species is rare in its native eastern Australian rain forests. It was discovered by C. Moore, Curator of the Sydney Botanic Gardens.

The members of the genus *Nothofagus* which appear to be best adapted to San Francisco are *N. obliqua* and *N. antarctica,* both deciduous species from South America. *N. alpina, N. solandri* and *N. moorei* seem to be less successful. The plants have not been observed by this author over a long period of time, however, and the current water stress may be affecting them adversely.

Acknowledgements

Pat Harrigan, Strybing Arboretum Society, all photography; George Georgeades, Assistant Director, and Jake Sigg, Strybing Arboretum, for aid in locating the plants; John Strother, the Herbarium, Department of Botany, University of California at Berkeley, for help in identification of some specimens.

REFERENCES

Bean, W.J. 1976. Trees and Shrubs Hardy in the British Isles, 8th ed., Vol. III. John Murray, London.

Elwes, H.J. and A.H. Henry. 1970. The Trees of Great Britain and Ireland. S.R. Publishers, Wakefield, England.

Gardens in Southwest England

Alcove in garden wall at Hestercombe House with *Chimonanthus praecox* growing beside it. All photos by Brian O. Mulligan

BY BRIAN O. MULLIGAN

In early autumn of 1977 we spent several weeks visiting gardens and arboreta in Great Britain, some of which we had also seen in the spring or early summer of 1973 or 1975[1]. Therefore these notes can cover, in such cases, both seasons of the year.

TRENGWAINTON (near Penzance, Cornwall)

This large garden is situated on a hillside overlooking Mount's Bay and the English Channel in the extreme southwestern corner of England. Since it is so close to the sea, frosts of any severity are quite rare, although in the exceptionally cold winter of 1962-63 a temperature of 10°F was registered on two nights, causing great devastation to the gardens in this area. The combination of a mild maritime climate and heavy rainfall (about 46 inches annually) allows an extraordinary number of normally tender trees and shrubs to be grown successfully.

Evergreen trees such as *Acacia, Cordyline, Drimys, Eucryphia, Michelia* and *Myrtus* are represented as well as *Azara, Cassia, Clianthus, Leptospermum,* and most notably rhododendrons, amongst shrubs. The tree forms of *Rhododendron* indeed live up to their character in this climate; for example, *R. arboreum, R. grande, R. macabeanum* and *R. magnificum* are splendid specimens. The Maddenii series and its hybrids are also well represented as one would expect. Tree ferns, *Dicksonia antarctica,* from Australia are so much at home here that they reproduce themselves from spores.

A spring feature of this garden must be the tree magnolias — *M. campbellii* and its subspecies *mollicomata, M. sargentiana* var. *robusta, M. sprengeri* 'Diva' and the hybrid *M.* × *veitchii* which is now 40 years old. All of them are now huge plants and must bear hundreds of flowers in good seasons.

The evergreen *M. delavayi,* native of southwest China (Yunnan), is renowned more for its leathery foliage than its short-lived and rather small, creamy white flowers in summer. It was still producing some flowers in early September, on a tree some 35 feet tall. (A specimen of it, planted against the west wall of the offices in our Arbore-

[1]See *Arboretum Bulletin,* Spring 1974 (37:2) for a description of Mr. and Mrs. Mulligan's visit to southwestern England in 1973.

tum in 1948, was eventually killed by the severe early freeze of November, 1955. Another later trial eventually met the same fate.)

At the time of our recent visit a magnificent specimen of the evergreen Chilean tree, *Eucryphia cordifolia,* over 30 feet in height was in full bloom in the walled garden, almost smothered by the profusion of its four-petalled white flowers. On the high wall behind it a golden yellow *Acacia* species was an unusual sight at this season. Another notable evergreen Chilean tree, *Myrtus luma,* stands on the lawn just west of the house; planted in 1890, it is conspicuous both for the warm brown coloring of its smooth bark as well as for the innumerable small white flowers late in summer or early autumn. *Clethra arborea,* an evergreen tree species native to Madeira, was flowering sparingly.

Along the southwest side of the long drive leading up to the house, a stream garden was constructed in the 1920s, bordering a small rivulet which flows all year. Moisture-loving herbaceous plants such as astilbes, irises, *Mimulus* and hostas grow on the banks. In the mixed woodland beyond, planted about 150 years ago, masses of a pale blue-flowered form of *Hydrangea macrophylla* light up dark areas.

In 1961 the owner, Sir Edward Bolitho, gave 98 acres to the National Trust together with an endowment to ensure future maintenance. The garden is now open to the public on four days a week from March to September.

While Trengwainton is principally a garden to be seen in spring or early summer there is so much unusual and fine quality plant material here that a visit would be well worthwhile at any time it is open.

KNIGHTSHAYES COURT (near Tiverton, Devonshire)[2]

This estate has become National Trust property since the death of Sir John Heathcoat Amory in 1972. With Lady Amory, he was responsible for its great development soon after World War II although there had been some plantings of rhododendrons, azaleas and other plants early in this century. Fortunately Lady Amory is still active in maintaining the garden.

Approaching the house up the winding drive visitors cannot fail to notice the huge old oak and beech trees in the fields on either side. A Turkey oak, *Quercus cerris,* is probably the largest in England; in 1970 it was measured at 128 feet in height, 22.5 feet in girth.

The walls of the century-old house are covered by vines and espaliered plants including *Magnolia grandiflora,* which is almost invariably seen trained on south or west walls in British gardens. The borders beneath on the south side are filled with those smaller shrubs and some herbaceous or bulbous plants that appreciate such a sheltered site.

Eastward from the house is a walk bordered on one side by a low wall and terrace in which a variety of small rock plants are happily situated. Above this wall are two different enclosed gardens, surrounded by old yew hedges. The first is planted with a variety of gray- or silver-foliaged plants and contains an old lead tank which is filled with different plants at various times of the year. The second was originally a bowling green. There is now a circular pool planted with water lilies with

[2]An additional description of Knightshayes appears in the Spring, 1974 issue of the *Bulletin*.

Enclosed formal garden and pool at Knightshayes Court, with statue in alcove of hedge.

Paeonia suffruticosa at Knightshayes Court.

a statue at the far end set in an alcove of the hedge. Beyond that stands an excellent specimen of the striking form of the sycamore maple, *Acer pseudoplatanus* 'Brilliantissimum' whose young foliage is colored a rich apricot. As an additional feature, at one side of the pool is a young tree of the weeping silver pear, *Pyrus salicifolia* 'Pendula.' These two gardens form interesting examples of totally different treatment of similar enclosed spaces.

Continuing into the woodland area beyond this walk there is a series of irregular borders and beds filled completely with a carefully planned selection of choice herbaceous plants which provide color and interest at different seasons; these include hellebores and euphorbias for the spring, *Meconopsis* and the uncommon *Ourisia coccinea* from Chile with its bright red, tubular flowers in May and June. Hostas and *Anemone* × *hybrida* (*A. japonica* of our gardens) bloom later in the year. Scattered amongst them are several large shrubs or small trees including *Pieris formosa* var. *forrestii* and the variegated form of the Japanese angelica tree, *Aralia elata* 'Variegata,' blooming in September as was the Chinese evergreen *Itea ilicifolia* with its long tassels of greenish flowers. However, a flourishing and flowering specimen of *Lyonothamnus floribundus,* 30 feet high, native to the Channel Islands off southern California, was undoubtedly the most surprising plant here. (It grew in our Arboretum for several years until it was killed by cold in November, 1955.)

Beyond this densely planted area is another woodland of more recent development, carefully thinned and containing beech, oak and some splendid Douglas firs with trunks up to three feet in diameter. Rhododendron species and hybrids include some of the large-leaved species such as *R. macabeanum* and members of the Maddenii series. A well-grown example of the variegated form of *Pittosporum tenuifolium* 'Silver Queen' is about 15 feet tall. A healthy plant of the beautiful *Paeonia suffruticosa* bears its great white, purple-stained flowers in May. In September, the area is lightened by numerous bushes of different forms of *Hydrangea macrophylla,* especially the large white 'Veitchii.' Representative collections of viburnums and hollies are also planted here.

In all, Knightshayes is a most varied and interesting garden; a full morning or afternoon can easily be spent there. It is open from April 1 to October 31, except on Fridays and Saturdays.

ROSEMOOR (Torrington, North Devon)

This late 19th century garden has recently been considerably enlarged. Among the more conspicuous earlier plantings are large trees of a Turkey oak, European silver fir, *Abies alba,* and the western American incense cedar, *Calocedrus decurrens,* planted between house and road. Lately a number of small trees have been introduced, such as *Acer griseum, Eucalyptus* species (some of which have been successful), *Sorbus* species, magnolias in variety, *Prunus sargentii* and others which will soon alter the appearance of the place.

A number of *Rhododendron* species are growing well on the hillside above the house beneath a canopy of native oak trees and accompanied by other shrubs. A border of rhododendrons across the driveway from the house contains the blue-flowered *R. augustinii* and its smaller hybrids.

Several raised beds near the house enclosed by rock walls three to four feet high are filled with choice or rare small shrubs, including some of the smallest rhododendrons, alpine plants and small bulbs. Behind this area is another stone wall protecting and supporting a selection of more or less tender shrubs and climbing plants. The fine form of *Clematis orientalis,* known as 'Orange Peel' because of the thickness of its sepals, flourishes here; it was introduced from southeastern Tibet only in 1947. (See article, p. 30.)

This garden is open daily to the public.

DR. J.A. SMART'S GARDEN (near Barnstaple, North Devon)

The owner began the development of this garden in 1960. The new house, erected 1972-73, stands on a ridge overlooking a small valley and stream-fed lake to the south. The garden extends from the road above the house down the

bank and across the valley for several acres, ending in a corner on the opposite side. It is now being extended into fields to the west.

The most distant portion has been rather densely planted with trees and shrubs, with a background of conifers, chiefly pines. There are several kinds of *Eucalyptus,* which thrive better here than at Rosemoor since they are nearer the sea. In addition there are also magnolias, *Nothofagus* species and *Stewartia* of several kinds. The Chilean genera *Embothrium, Crinodendron* and *Drimys winteri* are represented. Among the rhododendrons is a fine plant of *R. macabeanum* of a good yellow color.

A path winds around the lakeside, which is planted with shrubs and herbaceous plants that enjoy moist conditions: dogwoods and willows, irises and species of *Primula.* Below the lake's outlet flourishes a massive clump of *Gunnera manicata,* displaying its enormous leaves to full advantage.

On the bank below the house a selection of Japanese cherry trees was planted about 1960. In sunny areas of this bank are various *Ceanothus* and *Mahonia* species and hybrids, and near its base is a small but gay planting of summer-flowering heathers.

West of the house on the same level is a rose garden, and beyond it a long, high wall which lends support to a varied assortment of the less hardy shrubs and climbing plants. The rich red *Clematis texensis* hybrid 'Gravetye Beauty' was conspicuous here in early September.

Behind the wall are several greenhouses, one of which is devoted to a collection of the latest camellia introductions from the United States, Australia and New Zealand. Dr. Smart is an internationally recognized authority on camellias and keeps his collection as up-to-date as possible, propagating the best for further distribution in Great Britain.

This garden is also open daily to visitors and would be of interest at any time from spring to October.

HESTERCOMBE HOUSE (near Taunton, Somerset)

Between 1904 and 1910 these gardens, dating back at least to the early 18th century, were redesigned and replanted by the team of Sir Edwin Lutyens, architect, and Miss Gertrude Jekyll, garden designer and plantswoman of long experience in the art. It is now one of the best remaining examples of their cooperation to be found anywhere in Great Britain. During the World War II and subsequently, they were neglected and the original designs and plantings were nearly lost. Fortunately this deterioration was recognized and arrested. In 1972 the original plans were reassembled and proposals drawn up for carrying out the necessary work of restoration, begun in the winter of 1973 but still not com-

View of Hestercombe House with garden designed and planted by Sir Edwin Lutyens and Miss Gertrude Jekyll. Notice in background the alcove pictured on page 12.

pleted although the major portion has been rehabilitated.

In addition to the portions of the garden shown in the photographs, the charming Orangery to the east of the house was also designed by Lutyens. The terrace wall beneath it is lined by plants of *Cistus,* rosemary and lavender, all native to the Mediterranean region. Twin shrubs of myrtle, *Myrtus communis,* also from the Mediterranean, guard the archway at the east end of the terrace which leads into the former Dutch garden, still being reconstructed. The south side of the main sunken formal garden is bordered by a long rose pergola.

Hestercombe is now the headquarters of the county Fire Brigade. Anyone wishing to visit it should telephone the Chief Fire Officer in advance. It is certainly a notable example of early 20th century garden design. ♠

Other gardens in this region, all in the ownership of the National Trust, are:

1. Killerton, about 10 miles northeast of Exeter, just off the road to Taunton. This dates back to 1920, has fine trees, especially conifers, and large old plantings of rhododendrons and other shrubs. Open all year.
2. Barrington Court, near Ilminster. This is a 16th century house with an extensive garden. Open all year.
3. Tintinhull House, near Yeovil, Somerset. A 17th century manor house with a 20th century garden. Open April to September.
4. Montacute House, near the latter. An Elizabethan House (1588) of golden sandstone, having a formal garden of the period and a picture gallery and original furniture in the House. Open April to September.

Gardens described in the *Bulletin* article of Spring, 1974, include:

1. Caerhays Castle, founded by Mr. J.C. Williams
2. Trewithen, near Truro, Cornwall. Mrs. G.H. Johnstone is the owner.
3. Hillier's Nursery and Arboretum, near Romsey, Hampshire.

Available from the Arboretum office

Hardback . . . . $8.50 Paperback $4.75

(A list of errata appears on p. 32.)

President's Message

With the final approval of the Updated Master Plan referred to by Joe Witt, below, the Arboretum Foundation now has the opportunity to assist in the implementation of the many recommendations contained in the Plan. Foundation priorities for Arboretum improvements have been made clear over the past several years and have been given renewed emphasis this past year. The plan meets most of our recommendations.

Foundation members will soon receive a letter outlining in more detail the elements of the approved Plan and asking for endorsement of ways in which the Foundation can assist the Arboretum and Botanical Garden Committee, the City and the University of Washington in putting the Plan into action. The momentum for progress should be maintained.

I request thoughtful consideration and support in this matter by all Foundation members.

Leroy A. Collins, Jr.

The Updated Master Plan

The Updated Master Plan for the University of Washington Arboretum in Washington Park was given final approval by the Arboretum and Botanical Garden Committee on January 20, 1978. When approved by the Board of Regents of the University and the Seattle City Council, the updated plan prepared by Jones & Jones, Landscape Architects, will give guidance to future developments of the Washington Park Arboretum. A final public hearing will be held March 2, 1978 and the plan will then go to the City Council and the Regents for their action. Briefly, the updating calls for a new visitors' center, replacement of the irrigation system, upgrading of trails, signing and labeling, guidelines for new collections and other features, and suggestions for changing the traffic flow through the grounds. Priorities for these various projects will be developed by the Arboretum and Botanical Garden Committee after final acceptance by the University and the City. *J.A.W.*

Special Programs

The Arboretum Foundation has sponsored a symposium on "Horticulture as Therapy" conducted by Mr. A.S. White. Mrs. Jack Docter was chairman of the event, which was of particular interest to those members of the Unit Council who are docents in the Hospital Program. An evening lecture on Monday, March 6th was followed on March 7th by a daytime workshop.

Another symposium will be co-sponsored by the Foundation on May 5th and 6th. This will be entitled "Management of Urban Open Space in the Public Sector" and is being arranged by Mrs. Margaret Maxwell, a graduate student at the University of Washington. Members of the Foundation will be informed of the details of this program by a special mailing.

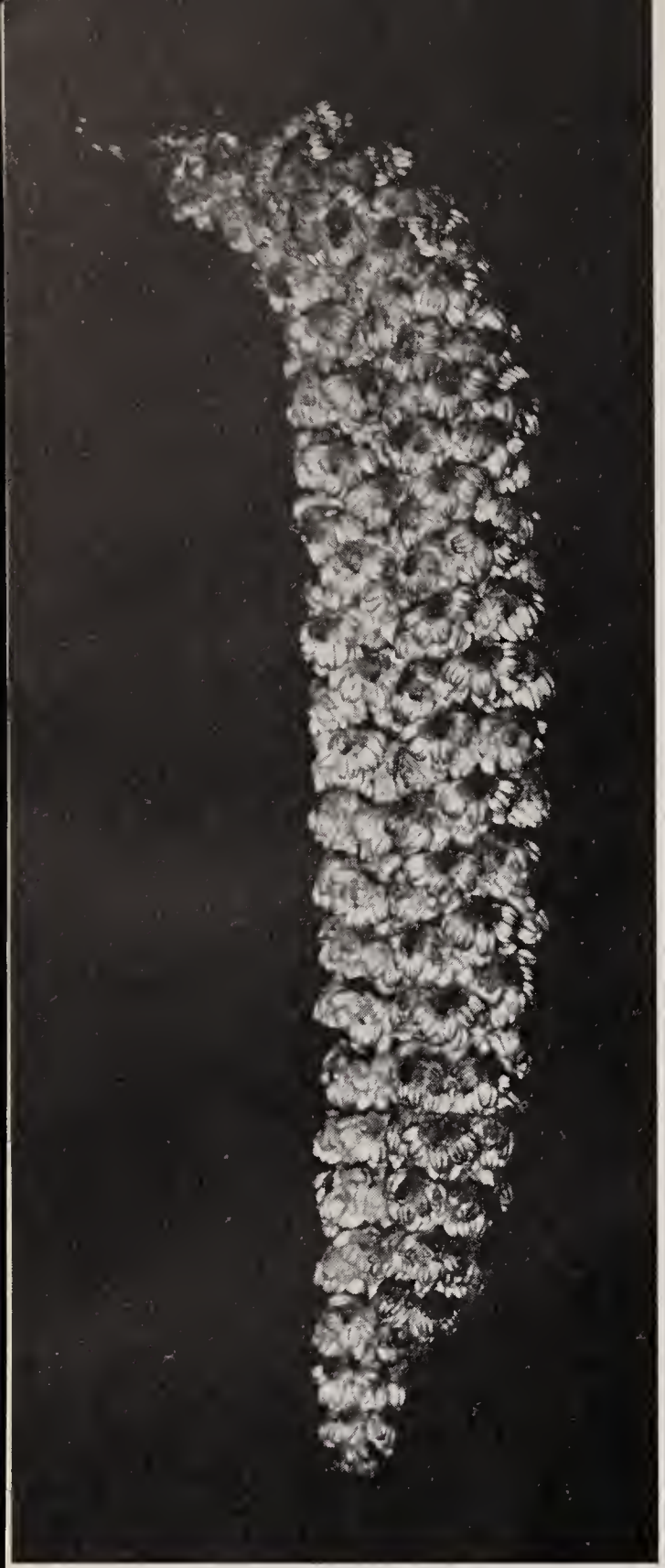


Fig. 7. Staminate flower of *Alnus rubra*.

Sexual Reproduction in Flowering Plants

*MELINDA F. DENTON**

Photographs by
SIGURD OLSEN

Fig. 8. Fruits of *Alnus rubra*.

Introduction

Reproductive systems in plants are generally more variable than those in animals. Plants not only have the option of reproducing sexually, but many can also produce new individuals by asexual means. Sexual reproduction is the principal source of genetic variability and allows characteristics to be recombined and introduced to succeeding generations. Asexual reproduction involves the formation of genetically identical individuals. The combination of both means of reproduction in some plants can be highly advantageous. When sexual reproduction is averted, either by physical damage to the plants or by fluctuating or unfavorable environmental conditions, those plants that are perennial and long-lived or that can reproduce asexually can usually persist until conditions are amenable for sexual reproduction.

The reproductive organs for flowering plants (angiosperms) are the flowers. Most species will form "complete," bisexual flowers that consist of sepals, petals, stamens and carpels. Variation in floral structure mostly occurs by changes in symmetry, by the fusion or loss of parts, or by a change in the number of parts. If any of the four parts is missing, then the flower is "incomplete." The sepals and petals are accessory in that they are not directly involved with the sexual life cycle of the plant, but they function to protect the reproductive structures as well as to attract pollinators to the flowers. The stamens and carpels are the essential parts of a flower because they produce the gametes, respectively sperm and eggs. If only one sexual structure is present, the flower is a unisexual one. If stamens are present (and carpels absent), the flower is staminate (male); or if the carpels are present (and stamens absent),

*Dr. Denton is Assistant Professor of Botany in systematics and Curator of the Herbarium at the University of Washington. For those who are curious about the arrangement of reproductive organs within a flower, this article will help to explain some of the functional aspects implied.

the flower is carpellate or pistillate (female). Each of the stamens generally has a ribbon-like filament terminated by a cylindrical anther. Pollen is produced in the anther. Individual carpels consist of a terminal stigma, an elongate style and a basal ovary containing the ovules. Often there are several carpels in the flower, and collectively, these make up the gynoecium; these carpels may be referred to as simple pistils if unfused, or as a compound pistil if fused into one structure. The number of ovules per ovary will vary from one to many, depending on the species. Each of the ovules contains a multinucleate embryo sac. One of the nuclei in the embryo sac is the egg which will develop into an embryo when fertilized by a sperm (from pollen). Usually two other nuclei in the embryo sac (the polar nuclei) develop into endosperm (the nutritive tissue of seeds) when fertilized by a second sperm released from the pollen tube into the embryo sac.

To obtain seeds, the product of sexual reproduction, pollen must be transferred to a receptive stigma (pollination). After a pollen grain germinates, the pollen tube grows through the style into the ovary where it penetrates an ovule and eventually releases two sperm into an embryo sac. After double fertilization (the union of a sperm with an egg, and the union of a second sperm with the two polar nuclei), a coat is formed around the developing embryo and endosperm, and a seed is produced. When the ovary containing the seeds has ripened, it is called a fruit.

The two modes of sexual reproduction are inbreeding and outbreeding. Inbreeding refers to a condition where the plants are genetically self-compatible and generally self-pollinating; in some instances, cross-pollination may occur so long as it is between genetically identical individuals. When plants are "crossed," pollen is transferred from the anther of one flower to a receptive stigma in a flower on a different plant. Selfing involves the transfer of pollen from the anther of a given flower to the stigma of the same flower. Sometimes pollen is transferred between flowers on the same plant, a condition (geitonogamy) that is genetically similar to selfing since new genes are generally not introduced to the next generation. Outbreeding plants may be either self-compatible or self-incompatible, and are genetically different and cross-pollinated. If the outbreeders are self-compatible, then floral mechanisms must have evolved to prevent selfing. If the plants are self-incompatible, selfing is prevented by the failure of a pollen grain to germinate on the stigma or by the inability of a pollen tube to grow through the style of the flower in which the pollen was formed. In both inbreeders and outbreeders, genetic control and floral mechanisms determine the actual type of reproductive system that is found in a particular species of plant.

Inbreeding

Autogamy, or sex and the single plant, is possible when bisexual flowers are self-compatible and self-fertilizing. Such autogamous flowers tend to be small, have monocolored sepals and petals (the perianth), lack nectar guides or nectaries and have stamens and carpels maturing simultaneously. The number of pollen grains and ovules produced is less than in outcrossing plants. Autogamous plants are good colonizers and typically occur in the first stages of ecological succession. They usually have a broad distribution, and are often known as "weeds." Seed-set is assured, and in most, if not all, the fruits produced on a given plant will form seed. Individuals in a population of autogamous plants tend to be very similar morphologically, with not so much variation as is noted in outbreeding populations. Occasionally, plants that are usually inbreeding will outcross. This capability will diversify the genetic make-up and sometimes will lead to an altered breeding system of the inbreeding species.

In some species of *Viola* (family Violaceae), flowers that never open (cleistogamous ones) are produced either at the beginning or at the end of the flowering season. In these same species, showy outcrossing flowers are also formed, but the presence of cleistogamous flowers (inbreeding) tends to insure at least some seed-set each year.

Outbreeding

Various methods of outcrossing have developed in flowering plants. If outcrossers are genetically self-incompatible, specializations in the flower need not be developed; however, many outcrossers are self-compatible, and in these, there have evolved floral modifications that serve to enhance cross-pollination. Outcrossing flowers tend to form showy perianths, nectar

(Continued on p. 22)

Fig. 3

Fig. 4

Fig. 2

Fig. 2. *Plantago lanceolata.*

Acer macrophyllum:
Fig. 3. Inflorescence.
Fig. 4. Staminate flower.

Salix scouleriana:
Fig. 9. Staminate inflorescence.
Fig. 10. Pistillate inflorescence.
Fig. 11. Flowering branch of staminate tree.

Photographs by
SIGURD OLSEN

Fig. 10

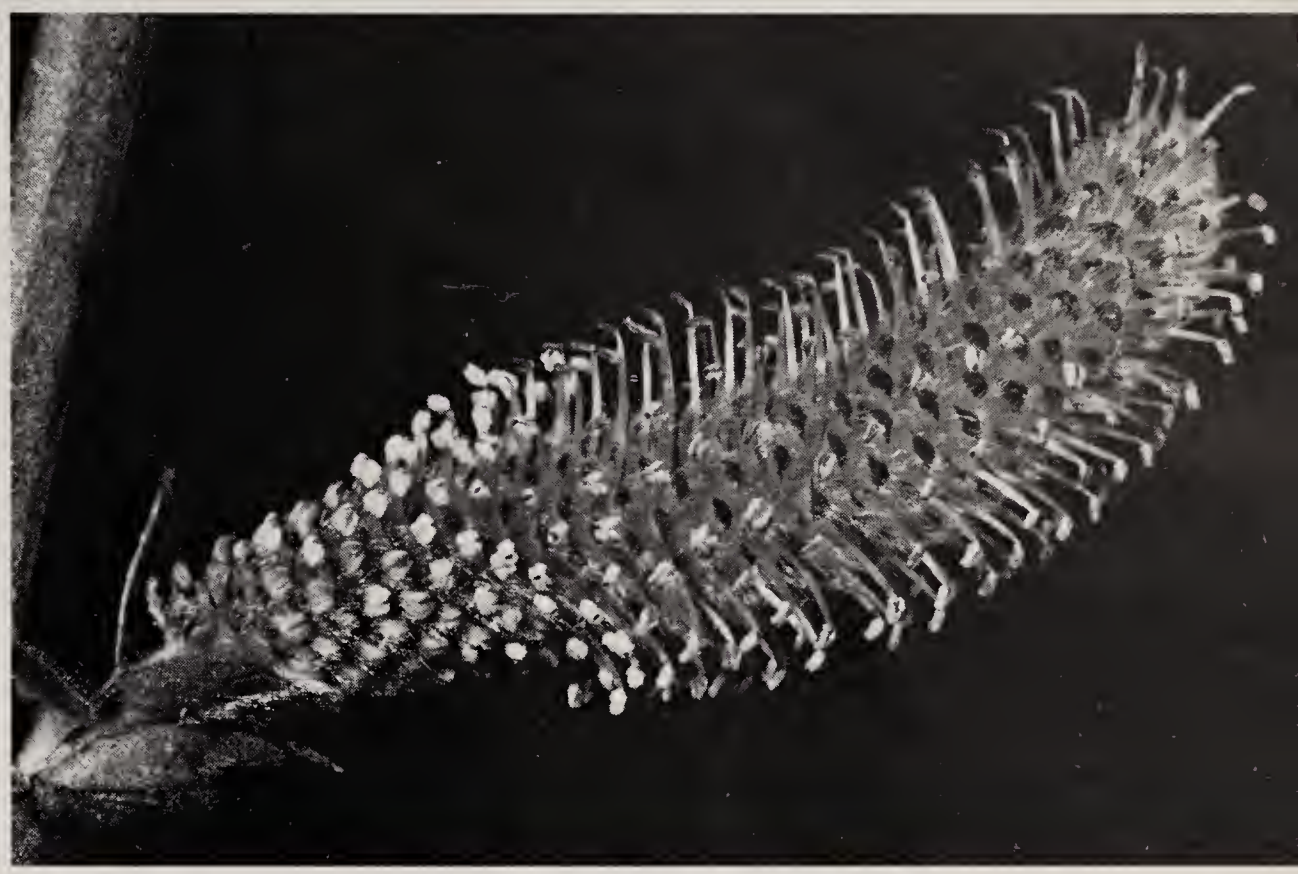


Fig. 9

Fig. 11

(Continued from p. 19)
guides and nectaries (if animal-pollinated), a large amount of pollen and numerous ovules, and reproductive structures that mature at different times. Because of the chance involved in successful pollination and fertilization, not all of the fruits will mature, and not all of the ovules will ripen into seeds. Many outcrossers are restricted in geographic distribution, and occur in plant communities that are stable and well-established.

The milkweeds (family Asclepiadaceae) and the orchids (family Orchidaceae) are two well-known examples in which there is spatial isolation of the reproductive structures. In milkweeds, the pollen is typically packed into hard masses with a waxlike appearance. These pollen masses are called pollinia and are spatially separated from the stigmatic area, thus preventing self-pollination. Pollinia are also found in orchids where they are physically separated from the receptive stigma by a sterile projection called a rostellum. If orchids are artificially selfed, seed-set invariably results. Van der Pijl and Dodson (1966) estimate that only three percent of the orchid species known to exist (over 20,000) are autogamous; the rest are outcrossers, with the Hymenoptera (mostly bees and wasps) responsible for pollinating 60 percent of the taxa. The orchids perhaps best exemplify the effectiveness of outbreeding by spatial separation of reproductive structures in genetically self-compatible, bisexual flowers.

Temporal isolation between the reproductive parts of a bisexual flower may occur when one part matures before the other. Protandry, the maturation and release of pollen from the anthers before the stigmas are receptive, is a good example. In several species of *Sedum* (stonecrops; family Crassulaceae), the flowers that open first in the cymose inflorescence are strongly protandrous, while the flowers that develop later in the same inflorescence tend to have the stamens and stigmas maturing contemporaneously. Even though there is often a breakdown in the floral mechanism that normally augments cross-pollination in *Sedum,* pollen must still be transported from the anther to the stigma by an animal vector, since the flower does not automatically self. Many mints (family Labiatae or Lamiaceae) and figworts (family Scrophulariaceae) and most composites (family Compositae or Asteraceae; Fig. 1, p. 23) are also protandrous.

Protogyny exists in a bisexual flower when the stigmas become receptive before the anthers release pollen. The common plantains (*Plantago;* family Plantaginaceae), with their flowers aggregated to form terminal spikes, show this type of reproductive isolation. On a single spike, the flowers will begin to open at the base, and will proceed to mature toward the distal or upper part of the inflorescence. At first, just the stigmas are evident; then as their receptiveness deteriorates, the stamens are observed. In the next tier of flowers, the stigmas will be evident at the same time the stamens are dehiscing pollen below. The degree of geitonogamy that may occur in this genus has never been thoroughly examined. In *Plantago lanceolata* (Fig. 2, p. 20), there is a genetic incompatibility system that inhibits any type of selfing (Baker, 1963). Carpellate flowers are also found in this species, either on the same plant as the bisexual flowers, or on a different one, conditions known respectively as gynomonoecism or gynodioecism. Although the flowers are adapted for wind pollination, insect visitors have been observed on the inflorescences. Variations in reproduction may be observed in two native plantains, *P. aristata* and *P. patagonica,* in which chasmogamous (open) and cleistogamous (closed) flowers are formed. Both of these species are annual and autogamous (Mesler, 1977).

In the western North American genus *Lomatium* (desert parsleys; family Umbelliferae or Apiaceae), the bisexual flowers are protogynous; at the height of flowering, there will be flowers at different stages of development on a single inflorescence or umbel. In desert parsleys, there are several umbels produced on each plant, and the first ones to mature have mostly (or exclusively) staminate flowers. Succeeding inflorescences will form bisexual, protogynous flowers at the periphery and staminate flowers toward the center of the umbel (Schlessman, 1976). The combination of bisexual and staminate flowers on the same plant is termed andromonoecism.

Acer macrophyllum, our native big-leaf maple, is also andromonoecious (Figs. 3 and 4, p. 20). Staminate flowers open first followed by the bisexual flowers. Both forms are produced in the same raceme. The stamens of the big-leaf maple are conspicuous by having long white hairs at the base of the filaments. The winged fruits, of

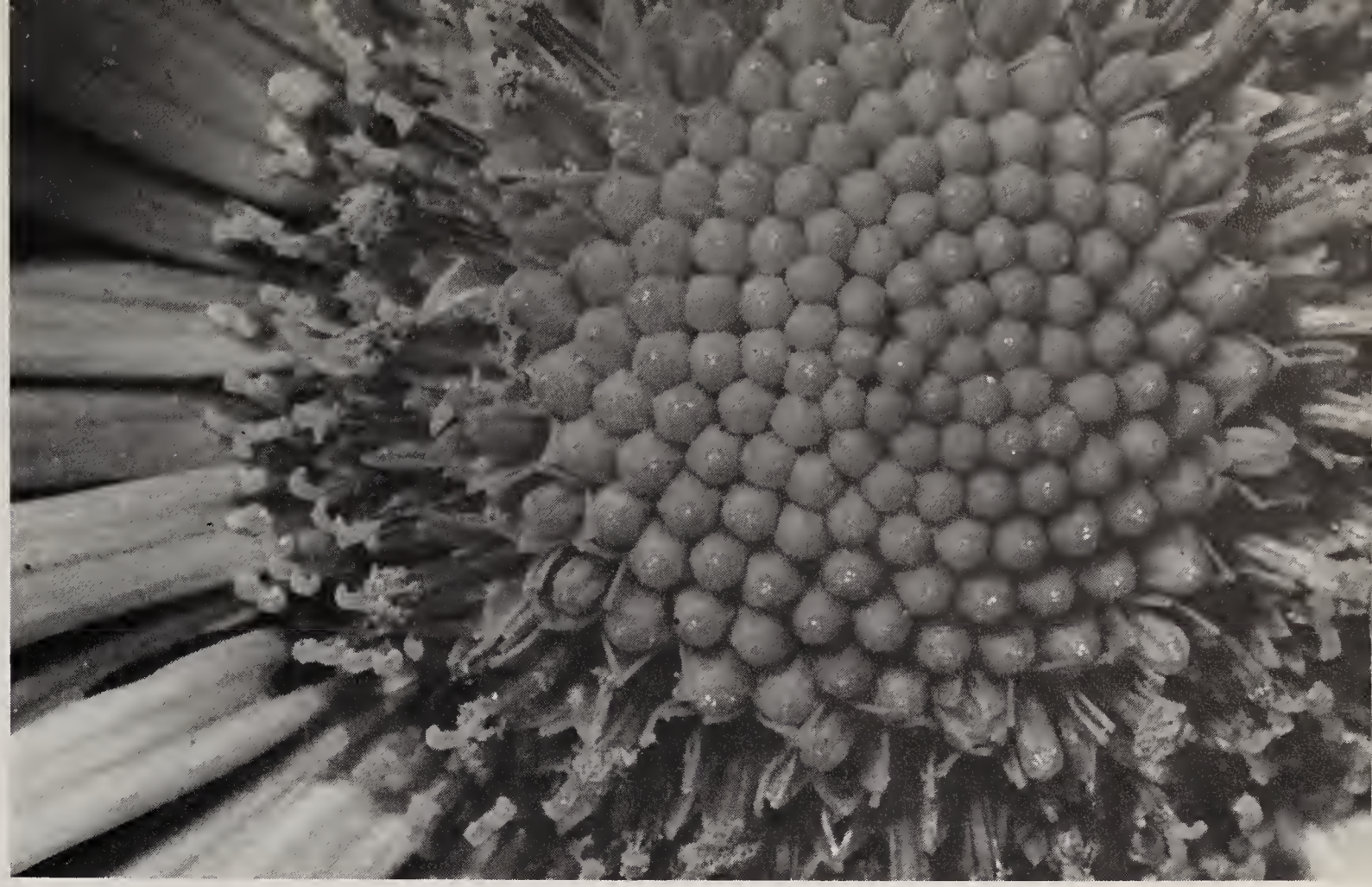


Fig. 1.
Typical sunflower, composed of numerous small flowers.
The stamens appear before the styles in the newly opened flowers (center ring). Styles do not appear until flowers are more fully developed (outer ring).

course, are developed in the bisexual flowers. Additional variation in breeding systems is found in the Norway maple (*Acer platanoides*) where the plants are polygamous in that they have staminate, carpellate, and bisexual flowers occurring together on a single plant.

When staminate and carpellate flowers are formed on the same plant, the condition is monoecious. In this case, the possibility for pollen from a staminate flower to be transported to a carpellate flower on the same plant exists, especially if the two sexes mature at the same time. Generally, the separation of sexes by different flowers is a means of enhancing outbreeding. In *Cupania guatemalensis* (family Sapindaceae), the monoecious plants first produce staminate, then carpellate and finally staminate flowers. The sexes on this tropical tree are temporally isolated (Bawa, 1977). In cattails (*Typha;* family Typhaceae), the carpellate flowers are closely situated in a brown spike and are located just below the light brown staminate spike (Fig. 5, p. 24). In the fall, the tufted fruits from the carpellate spike gradually break away and are wind-dispersed (Fig. 6, p. 24). In the birch family (Betulaceae), all of the genera are monoecious; *Alnus* (alder Figs. 7 and 8, p. 18) and *Betula* (birch) are two common representatives. Practically all of the birches form staminate and carpellate catkins early in the spring before the leaf canopy develops, thus facilitating wind pollination. In corn (*Zea mays;* family Gramineae or Poaceae), the staminate flowers are produced in tassles at the top of the plants while the carpellate flowers are formed on "cobs" in the leaf axils. The ovaries of the carpellate flowers, if fertilized, will ripen into kernels of corn.

In wet meadows, along streams, or around lakes in temperate regions of the world, species of *Carex* (sedge; family Cyperaceae) are common. There are over 1100 species of *Carex,* and all but a very small percentage are monoecious. The staminate spikes are usually borne above the carpellate ones, but occasionally staminate flowers are intermixed with the female flowers on the same spike. Each of the carpellate flowers is encircled by a special modified bract called a perigynium. When a fruit (achene) is mature, it is dispersed while still enclosed within the surrounding perigynium. Although most species of *Carex* are probably outbreeders and wind-pollinated, there have been reports of a few autogamous species. *Carex pedunculata,* for instance, has the ability to self-fertilize (Handel, 1976). The capability of this species to inbreed is advantageous since the propagules are usually dispersed singly, so that there is a considerable chance that the plant produced from a particular propagule will have to live and reproduce by itself.

Dioecious species are those in which staminate and carpellate flowers are formed on separate plants. Generally, the flowers on these plants are small, and white, yellow, pale green or light brown. This reproductive system is more common in plants with a woody habit than in those with a herbaceous habit. The costs of dioecism are high because only the carpellate plants produce seeds. The advantages of insured outbreeding and a continual influx and exchange

of genes tend to offset the disadvantages of dioecism.

Tropical floras exhibit a higher incidence of dioecism than do temperate floras. Bawa and Opler (1975) have attributed the evolution of dioecy in the tropics to the ease with which this reproductive system can apparently arise from the numerous, often "primitive," woody plant families available, the increased pollinator success under certain conditions, the enhanced escape from seed predators under dioecious conditions (less crowding of the plants that actually produce the seeds), and to the exploitation of a wider variety of microhabitats (especially by staminate plants since they can afford to spend less energy in the production of flowers and consequently more in vegetative growth).

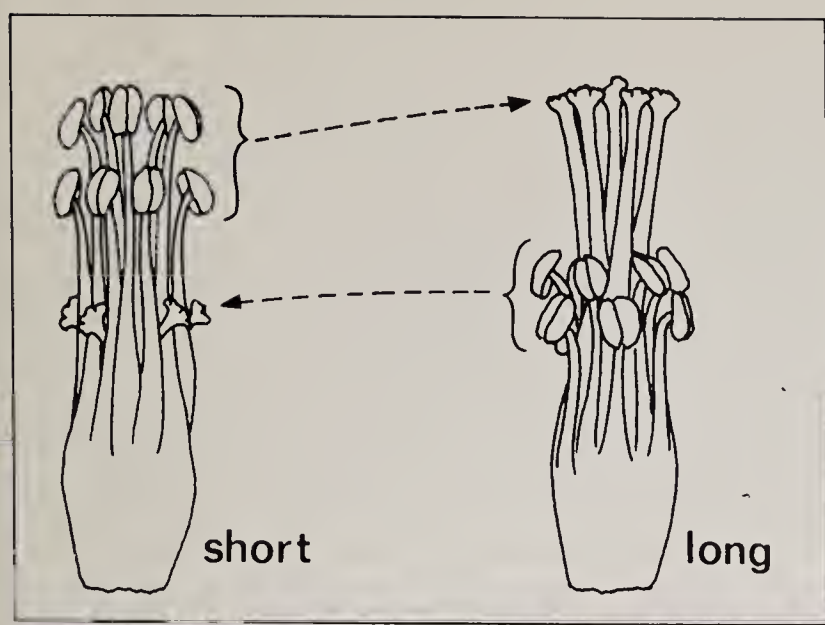
In temperate plants, the adaptation of flowers for wind pollination is probably a precursor to the development of unisexual flowers, and subsequently monoecism and dioecism. Wind pollination could have arisen as a response to a climate with very distinct seasons or to fewer pollinators.

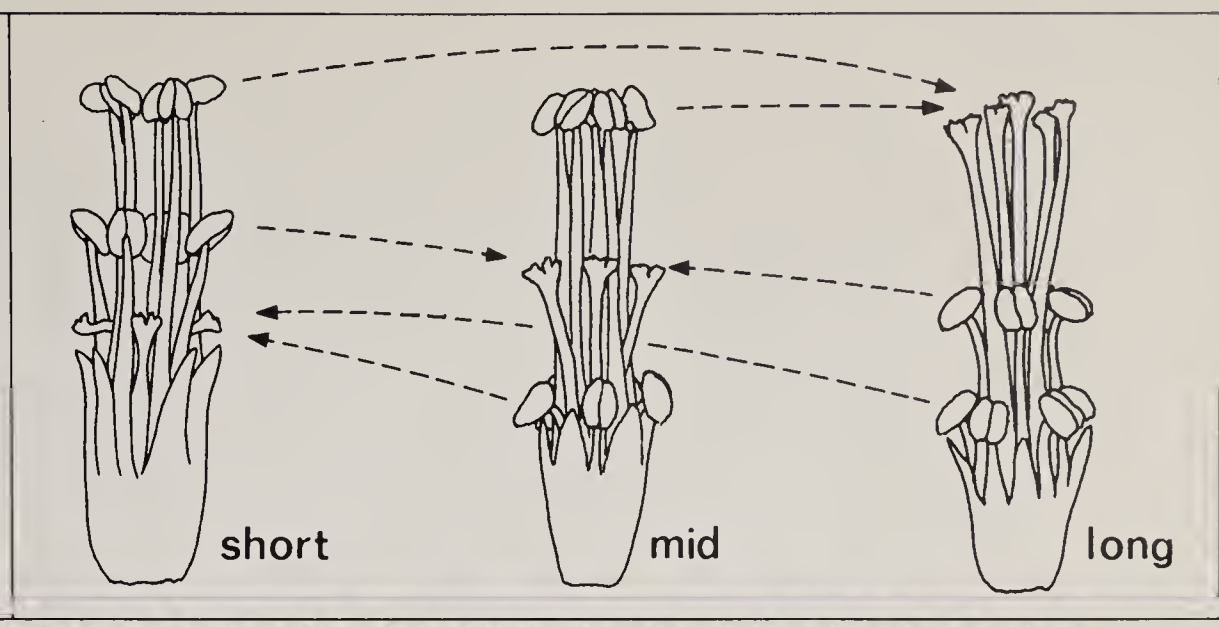
Once plants have evolved dioecism, there is little change in the way they reproduce. It is an irreversible reproductive system, and some have claimed that it has stopped the evolutionary development of those species that display it. Occurring sporadically in about 75 percent of the angiospermous families, dioecism is frequent in those families that are either geographically restricted or small and evolutionarily isolated. For example, dioecious species account for 27.5 percent of the native flora of the Hawaiian Islands and for 14.5 percent of the flora of New Zealand (Carlquist, 1966). In contrast, about 2 percent of typical continental floras are dioecious. For California, 2.6 percent of the flora are dioecious (Baker, 1967), while in the flora of the Pacific Northwest a recent count reveals that 3.2 percent of the species are dioecious. In the Northwest, the Salicaceae (willows and poplars) are the prevalent dioecious family.

The dioecious willows have both the staminate and carpellate flowers clustered into catkins (Figs. 9, 10, and 11; p. 21). These inflorescences are usually conspicuous early in the spring before the leaves have unfurled. Although most willows are wind-pollinated, some species are pollinated by Hymenoptera and Diptera. At the base of the carpellate flower in the insect-pollinated species is a large glistening nectary. Each ovary contains numerous ovules, which when fertilized, develop into tufted seeds. In late spring or early summer, the dry dehiscent fruits (capsules) open and release the tufted seeds which are then carried away by air currents. *Salix scouleriana* (Scouler's willow), the most common species of willow in lowland western Washington, occurs either as a shrub or tree and can usually be identified by its gray bark and obovate leaves.

Heterostyly is another outcrossing mechanism found in about 30 of the angiospermous families. In this type of breeding system, two or three forms of bisexual flowers may exist for each species.

***Typha* species: Fig. 5 (left) in summer. Fig. 6 (right) in autumn.**





Diagrams of heterostyly: Fig. 12 (left) distylous breeding system. Fig. 13 (right) functional tristylous breeding system. Drawings: S.G. Weller

Heterostyly provides morphological distinctions between plants that are genetically compatible. It is a specialized reproductive system which offers many advantages for the study of breeding systems in general since the different forms of flowers can be easily recognized.

In distylous species (Fig. 12, above), where two forms of flowers occur, one of the floral forms will have short stamens and long styles while the other form will have long stamens and short styles. These two floral forms are reciprocally compatible, but cannot be selfed or crossed with a like form. Long-styled flowers (pins) must be crossed with short-styled flowers (thrums) to produce good seed-set. The garden *Forsythia* (family Oleaceae) is a distylous plant. In some distylous species of *Primula* (family Primulaceae), there have been a few instances where the distylous outcrossing system has been altered to one that allows selfing. When this happens, the flowers are genetically self-compatible, and the reproductive parts of the flowers often are about the same length (homostylous condition).

When there are three floral forms per species, the reproductive system is termed tristylous (Fig. 13, above). The long-styled flowers have two whorls of stamens below the stigmas, and each of the whorls is of different length, creating three levels of reproductive parts within the flower. Mid-styled flowers have one whorl of stamens above the stigmas and one below. Short-styled flowers have two whorls of stamens of different length above the stigmas. Successful pollination between the three floral forms is reciprocal at similar reproductive levels and, as in distyly, selfing or crossing with a like form is prevented by a genetic incompatibility system. Only three angiospermous families exhibit tristyly: Oxalidaceae, Lythraceae and Pontederiaceae. The sorrel family (Oxalidaceae) is diverse in having tristylous, distylous and homostylous (often autogamous) species. The small, weedy, yellow-flowered species of *Oxalis* prevalent in the garden and in greenhouse pots are usually homostylous and autogamous. The tristylous species of *Oxalis* that have been studied tend to be restricted geographically, while the distylous species have wider distributions (Denton, 1973; Weller & Denton, 1976). Showy species of this genus, native to Mexico, South America, and South Africa, are well worth cultivation and investigation.

LITERATURE CITED

Baker, H.G. 1963. Evolutionary mechanisms in pollination biology. Science 139:877—883.

Baker, H.G. 1967. Support for Baker's law — as a rule. Evolution 21:853—856.

Bawa, K.S. 1977. The reproductive biology of *Cupania guatemalensis* Radlk. (Sapindaceae). Evolution 31:52—63.

Bawa, K.S. and P.A. Opler. 1975. Dioecism in tropical forest trees. Evolution 29:167—179.

Carlquist, S. 1966. The biota of long distance dispersal. IV. Genetic systems in the flora of oceanic islands. Evolution 20:433—455.

Denton, M.F. 1973. A monograph of *Oxalis* section Ionoxalis (Oxalidaceae) in North America. Publ. Mus. Michigan State Univ., Biol. Ser. 4:455—615.

Handel, S.N. 1976. Dispersal ecology of *Carex pedunculata* (Cyperaceae), a new North American myrmecochore. Amer. J. Bot. 63:1071—1079.

Mesler, M.R. 1977. Notes on the floral biology of *Plantago* in Michigan. Michigan Bot. 16:73—83.

Schlessman, M.A. 1976. A systematic study of *Lomatium farinosum* (Geyer ex Hooker) Coulter and Rose (Umbelliferae) and its relatives. M.S. Thesis, University of Washington.

van der Pijl, L. and C.H. Dodson. 1966. Orchid flowers, their pollination and evolution. The Fairchild Tropical Garden and the University of Miami Press, Coral Gables, Florida.

Weller, S.G. and M.F. Denton, 1976. Cytogeographic evidence for the evolution of distyly from tristyly in the North American species of *Oxalis* section Ionoxalis. Amer. J. Bot. 63:120—125.

The Reforestation of Seattle

Seattle waterfront with Yesler Mill and old Colman Dock, about 1870's-1880's. Photo: Courtesy of the Seattle Historical Society

MARVIN BLACK
Seattle City Arborist

People : tree relationships have gone through three stages in Seattle's history. The pendulum-swing differences in the three make an interesting story, related here with particular emphasis on Seattle's street trees.

Henry Yesler's sawmill was more than simply an early Seattle business. It was the rock on which the fledgling city based its fortune and its identity. Seattle's first love affair with its trees didn't carve hearts and initials in their bark; it cut them down. Today no tree remains from Lake Union to the Duwamish swamps, from the Freeway west to the Sound, that was growing when Seattle was incorporated 109 years ago, and few trees that old remain on either Queen Anne or Capitol Hill. Ironically, probably the oldest tree in the downtown area is an old cherry in the middle of the block bounded by First and Western Avenues north from Virginia Street, and it is slated to be logged this September for new buildings connected with the Pike Place development area! To residents of the young city, firs and cedars were cash, maples were firewood, alders were weeds, and it was too bad about the dogwoods and madronas.

When Seattle burned in 1889, the fire consumed buildings, not trees. It's as if the great fire was projecting Yesler's Mill as a premonition of future logging operations in the Pacific Northwest. So the logging climbed out past Issaquah into the foothills, and that was Stage One. The spirit of that era still lives in a lot of Seattleites who see trees as cash for the cutting or as nuisances in the way of money in the bank. Contrast this with Philadelphia which carefully protects its trees planted nearly 300 years ago by the earliest settlers, and where 200-year old street trees are almost commonplace.

For 100 years, Stage One was dominant, casting a continuing influence greater than Stage Two, which arrived after the fire. Stage Two was typified by the Olmsted Plan, released in 1908 and revised in 1928. Its creators, the Olmsted brothers, had a famous father who had designed New York's Central Park, and their plan proposed to beautify Seattle with a system of parks and tree-lined boulevards. A new lakeside boulevard — Lake Washington Boulevard — would tie together Seward Park, Mount Baker Park, Colman Park, Leschi Park and Washington Park. Interlaken Boulevard wound through dense woodland for a mile westward from it; this stretch

is my choice for the most brilliant bit of tree conservancy in town. Green Lake Way circled that lake, with Ravenna Boulevard extending eastward. Queen Anne Hill got a part-halo of planted boulevards. Magnolia Boulevard with its park along the bluff graced that part of the city, along with Condon Way. On Mount Baker, there was Mount Baker Boulevard and Hunter Boulevard.

All these boulevards were good for a Sunday drive. Curiously, all of them bordered the choicest Seattle neighborhoods at that time, and if one lived there one could find in the parks and boulevards an extension of one's grounds into an English countryside bit of romance. Without this great boulevard system Seattle would be infinitely poorer.

Before the fire, when the new mansions of Seattle's finest were photographed or described in the newspapers, gardens were conspicuously absent. Now, in Stage Two, with Culture arriving from afar in the form of parks and boulevards, the newly-rich emperors discovered they had no clothes. It became important to impress, usually by importing European copies, building echoes of Versailles or English pleasure grounds on one's property. These often echoed the naturalistic British influence of the new parks, and repeated the theme of developing beautiful vistas and putting lots of space between the genteel owner and the hoi polloi beyond the hedges.

Much of this Stage Two spirit joins with the Stage One remnant today in people : plant relationships. If Stage One was Cut Them Down, Stage Two was Replace Them, but this time with selectivity; economics was still a factor — the hiding of unpleasantness enhanced property values. But the planting of plants and trees along the streets was now public policy in Seattle, after 50 years of lost time. And the already-advantaged areas of the city got the major benefit from the new policy.

Stage Three could be titled, A Tree For Everybody. It was the age of Forward Thrust. In voting for that 1968 bond issue, Seattleites approved a proposal to plant trees and to establish Green Triangle miniparks on arterials all over the city. In the 10 years before Forward Thrust, Seattle had planted 1,000 trees, mostly on the streets bordering the World's Fair, on the Fair's umbilical streets to downtown (we had trees flanking a monorail!) or on downtown streets. In a little over five years, Forward Thrust trees on arterials raised this total of 1,000 non-boulevard street trees past 16,000.

And democracy arrived in Stage Three. Ballard and Fremont and the Central Area neighborhoods got trees and mini-parks; so did Beacon Hill and Lake City, South Park and West Seattle. Great lines of trees began to green Seattle's main

Avenue of hornbeams *(Carpinus caroliniana)* on Lake Washington Boulevard E. near 39th Avenue E. Photo: William Eng

entry arterials. Rainier Avenue received a beauty treatment — five miles of trees. Roosevelt Way/ 15th Avenue NE got five miles, and two to three miles each went to 35th Avenue NE, 35th Avenue SW, 23rd Avenue, Aurora Avenue. Major tree plantings went in on Beacon Avenue and 14th Avenue S, California Avenue SW and Admiral Way, 15th Avenue NW, Denny Way, Madison Street, Fairview Avenue E, West Marginal Way SW, Fourth and Fifth Avenues downtown, Empire Way. All over town the trees arrived: 15th and 19th Avenues E, N 45th and 46th Streets, Fremont Avenue N, Leary Way N, NE 125th Street, Broadway Avenue, 25th Avenue NE, N 36th and N 39th Streets, S Connecticut Street, NE 50th Street, Roy Street N, SW Roxbury Street, NE Pacific Street, 16th and 8th Avenues SW. Fifty Green Triangle parks popped up like mushrooms after rain. The City Council decreed that six neighborhoods had gotten less than their share in this great tree explosion, and voted additional trees for Greenwood, Wallingford, Greenlake, Ravenna, Montlake and Rainier Valley. Careful planning and community donations extended this program into Queen Anne and Magnolia, which got its first few non-boulevard trees. Infusions of federal money brought more tree planting into Central Area neighborhoods like Madrona and Yesler-Atlantic, and to South Park and Ballard. The Downtown Seattle Development Association collected funds from property owners, added a hefty grant from the state Bicentennial Commission and installed much-needed trees on Union, Seneca and Madison Streets, presenting them to the City as a bicentennial gift. Madison and Seneca Streets received additional new City plantings up onto First Hill; Pine and Pike are about to get similar treatment. Pioneer Square streets began to green up, and the reforestation reached within a stone's throw of Henry Yesler's old mill site.

After seven years of furious planting, Seattle has come from nowhere to an enviable network of 20,000 street trees rivaling San Francisco's best-on-the-coast position. Seattle's downtown area probably has a higher percentage of its streets with trees planted in the ground than any West Coast city. Concurrently, even the genteel boulevards have mostly become bikeways, and the masses now pedal ten-speeds past the big old houses.

Seattle 30 years from now is sure to be acclaimed as a city noted for its beautiful trees. Those who conceived the plantings, those who proposed and appropriated funds for them, and those who installed and cared for them will be hailed as foresighted.

All that is 30 years away, and it is as sure as rain. However, there is some present and future pain to be endured, and there are some knotty solutions yet to be found before the 30 years pass. Things are not as rosy as the foregoing narrative would make them appear.

What is this pain? *Dollars.* How to provide the budget to properly maintain the plantings the City has installed, as they grow both in age and extent. We are continuing to plant, in response to continuing citizen demand. Our love affair with trees this time is no casual thing, it is fanatical. Seattle's general fund revenues (this is where maintenance money comes from) are relatively constant from year to year. Tax increases are anathema to voters. Inflation has eroded the situation to the crisis point as wages and costs climb yearly. Increasing budgets to maintain increased tree plantings — or even just to meet inflation — means reducing other City programs that share the pot. Instantly, advocates of more trees are asked, "What other service should be cut to provide the money: the library budget? the fire department? maintenance of streets? park facilities?" The argument isn't whether trees are desirable, the problem is how to pay for these teenagers as they grow to maturity.

How about dropping maintenance, letting the trees fend for themselves? Public plantings, given benign neglect, die at an alarming rate. Seattle's experiment with sharply reduced park maintenance in 1974-75 was finally reversed by City Council directive; quite simply, the plantings were dying and we were losing the investment. In another Seattle instance, 500 of our street trees were left to fend for themselves after two years of care. Three years later, 200 were dead or missing. Dozens of U.S. cities have tried the same experiment with generally disastrous results. Though trees are pretty tough, street trees are organisms living in a relatively hostile environment, and usually someone must help care for them at least during the first 10 to 20 years.

In Seattle we have dropped to austerity-level street tree maintenance, a level nevertheless that includes routine care aimed at meeting the trees' most critical needs. Fortunately, Seattle resisted

the temptation to plant tens of thousands of tiny, cheap trees, and the choice is paying off now. These larger, more sturdy trees, of superior varieties, plus comprehensive care after planting, have given Seattle a tree mortality rate far below the national average despite this austerity care.

More pain: we now have to consider the possibility of nearly discontinuing maintenance of City-installed trees on our residential streets, trusting that residents' pride in their property will prompt them to care for the trees as if they had planted them, minimizing losses. At present, we no longer plant trees in front of any home whose owners object to a tree. In the future, it is unlikely that the City will agree to plant trees on residential streets unless the homeowners sign an agreement to care for them.

Trees on arterial streets are another matter. Voters approved the Forward Thrust bond issue that specifically restricted its tree plantings to arterial streets (all Forward Thrust plantings are completed). Arterials, usually uglier than residential streets, often contain large stretches of property controlled by absentee owners. To such owners the idea of street trees is sometimes the lowest of all priorities: the Stage One spirit. Such owners can scarcely be expected to help keep trees alive, much less healthy, if the task is tossed to them. Arterials have another quality, that of linking a diversity of business districts through residential neighborhoods, industrial areas, and the like. To allow everybody on arterials to prune his City-planted tree to his taste would nullify much of the concept that such long arterial plantings should be unifying elements. The City, to realize the 30-year dream, virtually has to provide much of such arterial street tree maintenance. The longer vision requires nurture, and is worth it; the end product will be trees with an appraised value 20 times what they now have.

Further additions to present arterial plantings — perhaps 5,000 more trees — need to be made within the next decade if vital links now missing in this arterial chain are to be completed. So the knotty problems mentioned earlier involve both how to survive present austerity with the trees intact, and how to complete the mostly-finished arterial picture.

Stage Three has left us with another problem. We have planted at such a dizzying pace that we have had little time to evaluate, to sort out all our mistakes and avoid repetition. During the last two years we have sharply increased the amount of cold-blooded evaluation given to our program. A number of earlier tree choices we now see as mistakes*. We have found ways to alter procedures and cut certain planting and maintenance costs, in a number of instances with innovative methods not used in other cities. The democratic rush to more trees, everywhere, has sometimes led all of us into a dangerous simplistic approach to trees as simply cosmetic, as plastic elements that will live in impossible places, and the like. We have sometimes used trees as pure censorship: there's an ugly sign, stick a tree in front to hide it. The knotty solutions to this type of problem lie in realizing that trees are living organisms that can't be made to jump through hoops at a whim; that we must commit ourselves to the lowest possible future maintenance cost by avoiding trees that inflict extreme damage on sidewalks, sewers, and buildings, by seeking alternative varieties; that we must continue a certain spirit of healthy innovation and experimentation that has characterized Seattle's approach; and that we must sometimes seek compromise solutions where trees can enhance a district without so many abrasive confrontations that divide the community, which the censorship approach promotes. ♠

Mini-park near Grosvenor House, Denny and 6th. Tree in foreground is *Quercus schumardii*. Photo: Nancy Walz

*These choices will be listed in a future article by Mr. Black.

Photo: Brian O. Mulligan

Clematis orientalis 'Orange Peel,' a well-established plant covering a fence in the garden of Mr. R.A. Banks at Kington, Herfordshire, England in early October.

Leaves from a Collector's Notebook

BRIAN O. MULLIGAN

1. *Clematis orientalis* 'Orange Peel'

In October, 1947 the late Frank Ludlow,[1] gatherer of botanical and zoological material and specimens during many years spent in the Himalayan mountain ranges, was returning from a year of exploration and collecting in eastern Tibet. He was accompanied by some of his trained native collectors. Although Major and Mrs. George Sherriff and Colonel Henry Elliott of the Indian Medical Service had collaborated with him on this expedition, they were not with him at this time.

Ludlow's journey involved about six weeks' trek north and then westwards along the valley of the great Tsangpo River, which drains southern Tibet and then cuts through the main Himalayan range in a deep and narrow gorge to flow into India as the Brahmaputra.

Seven days after leaving the hamlet of Tse where the river is a mile wide, he gathered seeds of two species of *Clematis*. One of these was *C. rehderana,* previously introduced by E.H. Wilson from western China in 1908. The other, however, L.&S. no. 13342, proved to be a new and superior form of *C. orientalis,* a species that grows wild over an enormous area in Asia from the Caucasus and Iran to China and Manchuria. It has been in cultivation in Europe for more than 200 years, having been named and described by Linnaeus in 1753. Since this plant is an extremely vigorous climber, it needs an old tree or other tall support over which it can scramble.

The leaves are pinnately compound with trifoliate, lanceolate glabrous leaflets of a light glaucous green. The yellow flowers, borne singly in the leaf axils of new shoots, appear in August and into September. They are nearly globular in the bud. The sepals are ovate-elliptic, acute, and an inch or more in length. Purple stamens surrounding the central tuft of styles add a touch of con-

[1]For data on the Ludlow and Sherriff expeditions I am entirely indebted to the pages of Dr. H.R. Fletcher's fascinating account of them in *A Quest of Flowers* (reviewed in the *Arboretum Bulletin* 40:1, 1977), particularly chapter six, "The Gorges of the Tsangpo."

trasting color. After flowering, the styles develop into the feathery plumed seeds typical of many species of the genus, adding noticeably to its ornamental value and extending its season.[2]

The pedicels are normally two to four inches long, but in this particular individual they are four to five inches, and the lemon-yellow sepals are exceptionally thick, the characteristic from which the name 'Orange Peel' is derived.

Three years after Ludlow's seeds were collected in that remote valley of the Tsangpo, a flowering plant was exhibited on October 10, 1950 by the Ingwersen Nursery of East Grinstead, Sussex at one of the Royal Horticultural Society's shows in London. It received a unanimous Award of Merit from the judging committee.

A plant of this *Clematis,* received at the Arboretum from the U.S. National Arboretum, Washington, D.C. in January, 1971, was planted in June of that year at the top of the bank just north of Rhododendron Glen. It faces west, against a large bush of native red huckleberry, *Vaccinium parvifolium,* which it now nearly covers. Although it has apparently not flowered, we presume it is true to name since the stock came from an excellent English nursery.

2. *Buddleia* × *weyeriana* 'Golden Glow'

This very distinctive hybrid between two totally different species of *Buddleia* was raised as long ago as 1914 by Mr. W. van de Weyer of Corfe Castle, Dorset, in southwest England.

The seed parent was the South American (Peru and Chile) *B. globosa*, which produces its orange-yellow flowers in small tight balls in an open panicle at the ends of new shoots. It blooms in summer, usually beginning in late June and continuing for some weeks. The shrub grows to about eight to ten feet tall. Though it is liable to damage from cold weather in some of our more severe winters, it generally recovers during the following season.

The other parent was a variety of the familiar butterfly bush, *Buddleia davidii* var. *magnifica*, one of E. H. Wilson's introductions from central China early in this century. It produces a long, dense, tapering terminal panicle of violet-purple flowers in July and August.

The hybrid is intermediate in the shape of its inflorescence, producing a number of ball-shaped, but somewhat looser, clusters along a shorter, but still tapering, compound panicle. Their color is much nearer the mother plant — an attractive light buff-yellow with a slight purplish tint to the buds. The foliage is much more like that of *B. davidii*, not so markedly lanceolate and wrinkled as that of *B. globosa*.

The specimen, photographed on September 9, 1977 in the garden of Lady Anne Palmer at Torrington, North Devon, England, was about six feet tall. It was still flowering profusely at that time and looked as if it would continue for some weeks.

This is a useful and attractive shrub which should be introduced to our Northwest gardens.

[2]See illustration of *C. tangutica* on the cover of the *Bulletin,* Fall 1968, 31:4.

***Buddleia* × *weyeriana* 'Golden Glow' blooming at Rosemoor, Torrington, North Devon, England.**

Photo: Brian O. Mulligan

All Arboretum Foundation members are invited to the Unit Council's first flower and foliage show:

Spring Horticulture on Display
March 30 & 31

To enter exhibits, see "Announcements from the Unit council" on page 35 and the *Unit Quarterly News*

Theme and Variation in Nature and Beyond

A night course offered by a member of our Editorial Board, Professor Reinhard Stettler, may be of special interest to our readers. The course description is as follows: "Within the near infinite array of possible variations in the world around us, we see finite themes: the aggregate of trees in a forest, the composition of a fugue, the developmental pattern of a frog, the sacred in human evolution. What are these themes? How do they emerge? How are they regulated and how do regulatory mechanisms themselves change over time? This course will look at these questions from an evolutionary perspective and is intended for lay persons. It will provide a biological background for exploring such topics as adaptation vs. adaptability, human impact on natural variation (how humans affect evolution), harmony and symmetry in natural systems and in art and architecture, planning for variation in urban design, our perceptions of variation. No scientific background required. For all persons interested in the world around them." Registration information is listed under U.W. Classes on p. 36.

Errors to be Corrected in the *Catalogue of Woody Plants in the University of Washington Arboretum*

p. 4 *Acer davidii* × *rufinerve*. Change to *A. davidii* × *A. rufinerve**.
9 *Actinidia callosa* var. *henryii*. Change to *henryi*.
46 Footnote. Change *"Clematic"* to *"Clematis"*.
76 *Ilex corallina* Franch. Insert × after Franch.
103 *Petteria ramentacea*. Change Yuglslavia to Yugoslavia.
108 *Pieris japonica* 'White Crusade'. Change to 'White Cascade'.
119 Add to *Prunus* × *wadai* Hort. Jap.
121 *Pyrus salicifolia* 'Pendula'. Delete "9". Insert period instead.
152 *Salix* × *tsugaluensis* Koidz. For 'Ginne' read 'Ginme'.
156 *Sorbaronia* × *sorbifolia*. *(A. melanocarpa* × *S. americana)*. Change capital X to ×.
163 TAXUS L. Taxaceae. Delete "3".

B.O.M.

Mrs. J. Wendell Trosper

All who knew 'Marty' (Martha Jane) Trosper admired the zeal with which she addressed herself to any project — and there are many which bear the stamp of her talents!

Probably her greatest project was her garden with which she was exceedingly generous. Horticultural knowledge as well as artistic perfectionism made it one of the most beautiful city-sized Seattle gardens and the high point of many garden tours.

'Marty' is greatly missed but her memory will be cherished by her many friends.

MARGE BAIRD

Garden Vignettes

Years ago my children owned a pet goat, and I was not amused the day I looked out and saw him happily standing with his forefeet in the center of my spindly four-foot *Cornus florida* var. *rubra,* nibbling at the foliage. As it turned out, I now have a pink dogwood with a very interesting curve to it and it has reached a height of about ten feet.

I have planted a *Clematis macropetala* 'Maidwell Hall' close by that meanders up through the foliage and along the branches of the dogwood so that when they bloom at the same time in May, it is a lovely sight. This clematis is a rather dainty variety with soft, lavender-blue, semi-double three-inch blossoms, comparable in size to the soft pink dogwood flowers — neither one overpowers the other.

An underplanting of *Lithospermum diffusum* 'Heavenly Blue' is very effective, although it does not cover itself with blooms in May as it does later in the season.

I have planted a group of *Schizostylis coccinea* 'Mrs. Hegarty,' the clear pink Kaffir lily, around the base of the dogwood to enhance its lovely fall color in late September and October. The Kaffir lily is a member of the iris family, which prefers sun and good drainage. Its fibrous, fleshy roots will travel along underground making a small but handsome group of ten-inch high iris-shaped leaves with two- to three-inch shell-pink blossoms in early fall. They should not be planted too close to the trunk of the *Cornus*, as they will eventually disappear under the low-hanging branches, but they are not deeply rooted and seem to enjoy their companions.

LEE CLARKE

During late winter it is always a pleasure to detour past our *Cornus florida* var. *rubra* to see what new treasure is peeking out from under the wide overhang of its knobby bare branches.

Erica herbacea (E. carnea) 'Springwood pink' is the tallest growing in a mass close to the tree trunk. Flowing downhill are thick rosettes of low primroses: lavender 'Sweetheart' *(P. vulgaris* var. *sibthorpii),* and the juliana hybrids, purple 'Wanda' (or 'Springtime') and the later pale yellow 'Dorothy.' Clumps of taller early *Narcissus* dot the level area — *N.* 'February Gold' and *N.* 'Peeping Tom.' Tumbling on down below are the tiny ones — *N. minimus (N. minor?), N. cyclamineus* and later in March *N. bulbocodium* var. *conspicuus* ('Hoop Petticoat').

The intense pink of my neat 12-year old dogwood is the solitary focus of attention during its late May bloom. The pink, combined with the thick deep green leafiness of the tree, is difficult competition for most other plants. After flowering, it settles back to a quiet summer. Suddenly, on a fall afternoon the sun's rays strike the deep red leaves and a new season is added to the beauty of that peaceful corner.

Myrtle De Friel suggests another combination of year-round interest centering about *Cornus florida* var. *rubra.* Immediately under its wide branches many forms of polystichum ferns flourish. Along the path in front of the dogwood are massed small-leafed early-flowering rhododendrons: *R. pemakoense, R. leucaspis* and *R. forrestii.* These have grayish or rusty foliage which turns bronzy in the fall and harmonizes with the changing shades of the *Cornus* leaves.

JEANNE GARDINER

In the spring when our pink dogwood is in its first flush of color, our garden is filled with the bloom of azaleas in white and tones of pink and red. One of the latter is *Azalea* 'Gladiator' which covers itself with sheets of crimson. At this time of year the red azaleas and the red-foliaged plants seem to find a focal point in the dogwood. *Photinia fraseri* and *P. glabra, Cotinus coggygria (Rhus cotinus), Prunus cerasifera (P. pissardii)* 'Vesuvius' and several laceleaf Japanese maples form a tapestried background against which its color is enriched.

Cornus florida var. *rubra* is a difficult subject partly because its flowers change dramatically from deep rose to shell pink. For us the white and soft reds planted nearby, with pinks kept in the distance, have been a successful approach.

J.P.-B.

Behind the Scenes at the Plant Sale

A little work, a little play,
To keep us going – and so, good day.
— George Du Maurier

Last year Arboretum Couples Club, Unit 52, took responsibility for setting up and taking down the Plant Sale, as they had done for at least six years before. It was a family effort — everyone pitched in — and afterwards they all went out to supper.

Their experience paid off: set-up, which was photographed by Jean Henderson, was finished by 6:30. The group is united in the belief that this unglamorous contribution would not be possible but for the fact that two of its members have access to large trucks.

When the sale was over, Unit Council Chairman, Lee Clarke, joined in with clean-up (photo, bottom right: Nancy Walz).

Announcements from the Unit Council

The Museum of History and Industry will be the scene of the first Unit Council Flower and Foliage Show to be held Thursday, March 30th from noon to 5, and Friday, March 31st from 10 to 3. Specimens in bloom or with interesting foliage, bonsai and house plants will all be displayed. The purpose of the show is to increase our knowledge of plant materials being grown in the area. It will not be judged, but Unit awards will be made. Entries will be received between 9 and 11 a.m. on March 30th. The public is invited to attend. Coffee, tea and cookies will be served.

Thursday, April 13th is the day set aside for sprucing up and weeding the Arboretum grounds. All Unit Council members and other persons interested in the appearance of the Arboretum grounds are encouraged to help with this undertaking. Margaret Schilling (Mrs. James), chairman of Work and Fun Day, promises it will be fun, too! There will be the annual contest for the best garden hat. Coffee will be provided. Bring a sack lunch, your own hand tools, and come, rain or shine.

The Bulb Sale this fall, under the guidance of Jeanne Gardiner (Mrs. Arthur) and Jane Rogers (Mrs. Stewart), announced profits of over $5,500. This year the Dutch bulbs were sold at a special sale at the Arboretum on October 4th and 5th rather than through pre-orders as in the past.

A new unit #93 has been formed in the Juanita district under the guidance of Jeannine Bannick (Mrs. Stephen), Doris Taggart (Mrs. Raymond) and Sally Sue Coleman (Mrs. Daniel).

RUTH MARY CLOSE

Notes and Comments

During the last six months, the Arboretum Foundation staff has undergone a series of changes because of illness. We hope that the situation is now stabilized under the competent leadership of Executive Secretary Margaret Kearns supported by Eden Wood as bookkeeper. The Foundation has set up a volunteer committee to help in the office at particularly busy times. Anyone who wishes to volunteer may call Lee Clarke, 232-1264, or the Foundation office, 325-4510.

Betty Brokaw (Mrs. Dean H.), a member of Unit 41, has agreed to be in charge of advertising for the *Bulletin.* She may be reached at 232-1142 or by calling the Arboretum Foundation office, 325-4510.

New Members of the Arboretum Foundation

We are pleased to welcome the following new members (August 31, 1977 through December 31, 1977):

Annual — Kathryn S. Adams, William J. Allsopp, Mrs. Clarence Ambrose, Bainbridge Island Garden Club, John and Janet Barr, E. Darlene Bickford, Mrs. John Boespflug, Mrs. John Bolles, Doris Bottorff, Wendell J. Bowerman, Miss Edna Breazeale, Deane Burnside, James A. Buss, City Wide Garden Club, Willis W. Collins, Mrs. Phyllis Conte, Nancy B. Coulter, Sarma Davidson, Donald C. Davis, S. Degenhardt, Sally Dickman, Mrs. Ann W. Dittmar, Margaret Dodworth, Marian Doubt, D. Duncan, Nancy Edwards, Mrs. Harold Fowler, Ruth Frankel, Mrs. Rita Fremouw, Mrs. Emogene D. Geyman, Kay Gordon, Ruth M. Griswold, Mitsuko Hakomori, Thomas Hankins, Mrs. Peter Harr, Mary D. Henry, Mrs. Catherine M. Hilton, J.D. Hinds, Mrs. Henry Isaacson, Jr., Mrs. Forbes Jones, Mrs. Bruce E. Joyce, Paul R. Kester, Mildred Kirkpatrick, Sieglinde Kisker, Valarie Lamoree, Mrs. Kenneth Lepic, Kyung Wha Lobdell, Mrs. John B. Lomax, Mrs. Debra Ann MacDonald, Mrs. K.M. MacDonald, Judy L. Mann, Lynn Marek, George R. Mattson, Becky McIntyre, Patricia McLellen, Frances I. Michaud, Mrs. Fred Miller, Luanne Morgenstern, Mt. View Garden Club, Mrs. Stuart G. Oles, Josephine Parpart, Doris J. Perrin, Jeanne E. Peterson, Vern H. Renius, Ridgecrest Garden Club, Janet Roen, Mrs. G.S. Russell, Mrs. Ronald K. Rutledge, Mrs. William Sandberg, Lee Savage, R.L. Shep, Stuart Simon, Alan I. Smith, Jane Smith, Sydney Smith, Arlene L. Sourbeer, T.E. Stephens, Joe Suchoski, Sue Sumioka, LaVerne Thennes, Lorene Tredway, Mrs. K.J. Usack, Vancouver Magazine Service, Mrs. Alex Walker, III, Irmgard Waring, Lenore Wegner, Reed A. Wendel, Barbara Whitney, Dorothy V. Yormork.

We are also grateful to the following who have increased their dues to:

Sustaining — James H. Andersen, Marcia J. Arnold, Ms. Jane Emerson, Mr. and Mrs. Joseph H. Rantz, Harold V. Smith, Mrs. John T. Story, Mrs. E.J. Strance.

University of Washington Classes

The *Bulletin* will be published this spring some weeks after *Spectrum*, the quarterly journal for Continuing Education, has been sent out. For that reason, some of the courses described below may already have been filled. We urge those of you who are interested in obtaining advance information to place your name on the mailing list for *Spectrum* by calling 543-2590.

Arboretum Courses

SPRING TOURS. Tours of the Arboretum grounds in spring bloom. Instructor: Joseph Witt. Class limited to 20; meet at Arboretum office. Saturdays, April 8, 22, May 6, 20; 10-12 noon. 4 sessions, $10.

BASIC GARDEN MAINTENANCE. Basic gardening techniques including soil preparation, planting, fertilizing, mulching, pruning, and seasonal care of plants. Instructor: Chico Narro. Class limited to 15; Arboretum greenhouse. Saturdays, April 1 through May 6; 10-12 noon. 6 sessions, $15.

IDENTIFICATION OF NATIVE TREES AND SHRUBS. Field class covering 40 species of common trees and shrubs native to western Washington. Instructor: Pat Duxler. Each section limited to 15; meet at Arboretum office. Saturdays, May 6 through 27; 4 sessions, $10. Section A: 10-12 noon; Section B: 1-3 p.m.

For further information on Arboretum courses, call 543-2730.

Continuing Education

WORLD PLEASURE GARDENS. This lecture series will examine pleasure gardens of eight different periods from the ancient Nile to modern Puget Sound. Coordinator: Prof. Norman J. Johnston, Architecture and Urban Planning. Thursdays, April 6 - May 25; 7:30-9:30 p.m. 8 sessions, $20.

THE MAKING OF THE ENGLISH LANDSCAPE. This course will consider how, why and when the countryside and towns came to be the way they are today. For past and future travelers and all those with interests in England, its history, geography and literature. Instructor: Barbara Haney, Ph.D., Lecturer, Geography. Wednesdays, April 5 - May 24; 7:30-9:30 p.m. 8 sessions, $25.

BIRDS IN THE FOREST ENVIRONMENT — A WEEKEND AT PACK FOREST. Includes bird identification, habitat, calls and the effects of forest conditions on bird populations. Limited to 30. Instructors: David Manuwal, Assoc. Professor, Wildlife Science; and Chadwick Oliver, Asst. Professor, Forest Ecology, College of Forest Resources. Friday evening through Sunday lunch, May 19-21; Pack Demonstration Forest; $65 (includes Saturday breakfast, lunch, dinner; Sunday breakfast, lunch; dormitory lodging, linens provided). No refunds after May 12.

THEME AND VARIATION IN NATURE AND BEYOND. Described on p. 32. Instructor: Prof. Reinhard F. Stettler, Forest Resources. Thursdays, April 6 - June 1; 7:30-9:30 p.m. 9 sessions, $25.

IDENTIFYING PLANTS OF THE PACIFIC NORTHWEST. This laboratory course is intended for persons who seek skill in identifying plants of the northwestern Washington fields and forests. No scientific background required. Recommended text: *Flora of the Pacific Northwest*, 2nd ed., Hitchcock and Cronquist. Instructor: Prof. Arthur Kruckeberg, Botany. Tuesdays, April 4-May 23; 7-10 p.m. 8 sessions plus one field trip, $45.

IDENTIFYING MOSSES AND LIVERWORTS OF THE PACIFIC NORTHWEST. Registration limited to 15. Instructor: Elva Lawton, Asst. Curator, Herbarium. Tuesdays, April 4 - June 6; 7-9:30 p.m. 10 sessions plus 2 field trips, $45.

INSECTS AND DISEASES IN ORNAMENTAL PLANTS. Instructors: Robert L. Edmonds, Asst. Professor, Forest Pathology, and Director of Pack Demonstration Forest; and Andris Eglitis, Ph.D., Forest Entomology. Mondays, April 3 - May 22; 7-9 p.m. 8 sessions, $25.

CALENDAR OF EVENTS

Arboretum Foundation:		Regularly Scheduled:	
Executive Committee	April 13	Greenhouse Day	Every Tuesday
	May 11	The Mae Granston Rhododendron Study Group	1st Monday
Annual Membership Dinner	June 9	Herbarium Committee	1st Friday
		Northwest Natives Study Group	3rd Monday
Unit Council:		Rock Garden Study Group	3rd Wednesday
Unit Council Meeting	May 18	Special Study Group	4th Monday
Governing Board	April 16	Arboretum Explorers	4th Wednesday
	May 11		
	June 1		

First Unit Council Flower Show: "Spring Horticulture on Display" March 30 & 31
Work and Fun Day April 13 **Arboretum Foundation Plant Sale May 3 & 4**

FOR INFORMATION CALL 325-4510

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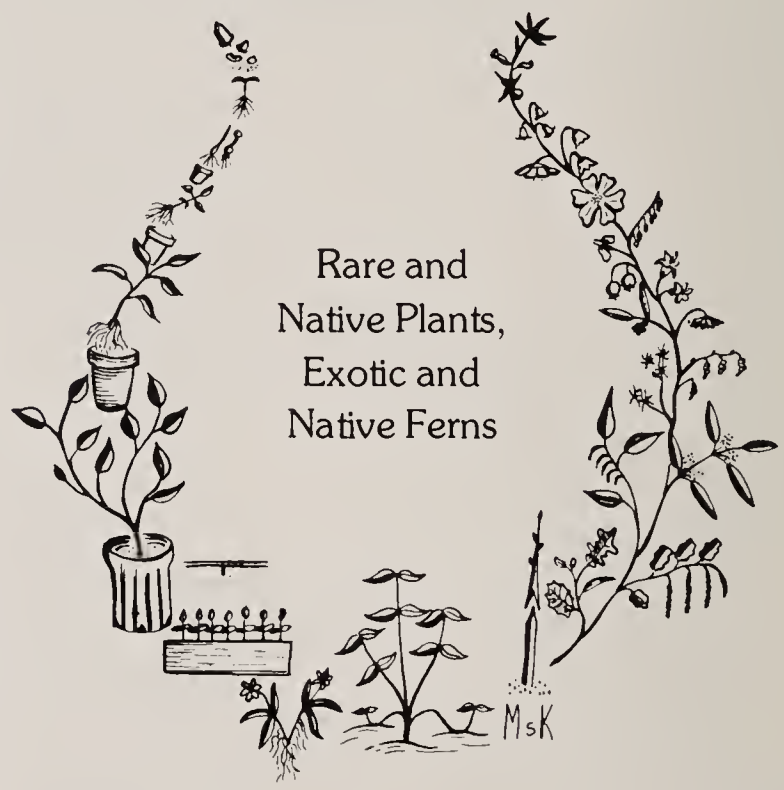

Arboretum Units, Garden Clubs and small groups are welcome to tour the Garden and Nursery.

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ANNUAL RHODODENDRON SHOW

May 5, 6 and 7

The Seattle Chapter of the American Rhododendron Society will hold their 28th Annual Rhododendron Show at the Bellevue Square Plaza May 5, 6 and 7. The Show will be open to the public from 2:00 P.M. to 9:00 P.M. on Friday, May 5, from 10:00 A.M. to 9:00 P.M. on Saturday and from 10:00 A.M. to 5:00 P.M. on Sunday.

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Typical scene at the
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April 13

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May 3 and 4

Join the Explorers' Walk, meeting every fourth Wednesday each month, in the parking lot of the administration buildings at 10 a.m. March 22, April 26, May 24 and June 28.